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CONTENTS

THE EMBRYOLOGY OF THE SERGEANT MAJOR, *Abudefduf saxatalis*. By *Evelyn S. Shaw* 85
Hadropterus pantherinus, A NEW PERCID FISH FROM OKLAHOMA AND ARKANSAS. By *George A. Moore* and *Jones D. Reeves* 89
THE DEVELOPMENT OF THE GAS BLADDER IN THE GREEN SUNFISH, *Lepomis cyanellus*. By *Arthur Edward Duwe* 92
STUDIES ON THE LIFE HISTORY OF THE ROSYFACE SHINER, *Notropis rubellus*. By *Rev. Roman A. Pfeiffer, O.F.M.* 95
FISH RESPIRATION IN THE NATURAL OXYGEN GRADIENT OF AN ANAEROBIC SPRING IN FLORIDA. By *Howard T. Odum* and *David K. Caldwell* 104
THE OPERCULAR BONE OF THE YELLOW PERCH, *Perca flavescens*, AS A TOOL FOR AGE AND GROWTH STUDIES. By *John E. Bardach* 107
A NEW GARTERSNAKE (*Thamnophis*) FROM TAMAULIPAS. By *Charles F. Walker* 110
FURTHER OBSERVATIONS ON THE DESERT TORTOISE, *Gopherus agassizi*, OF CALIFORNIA. By *Loye Miller* 113
A NEW SPECIES OF FROG OF THE GENUS *Eleutherodactylus* FROM GUATEMALA. By *Carlos B. Bumzahem*. 118
THE INGESTIVE, DIGESTIVE AND RESPIRATORY SYSTEMS OF THE MICROHYLID TADPOLE, *Hypopachus aguae*. By *R. Maxwell Savage* 120
LIFE HISTORY PATTERNS OF THE SALAMANDER *Ambystoma macrodactylum* IN THE HIGH CASCADE MOUNTAINS OF SOUTHERN OREGON. By *James Kezer* and *Donald S. Farner* 127
EARLY DEVELOPMENT OF TWO SUBSPECIES OF THE SALAMANDER, *Triturus cristatus*. By *Harold Fox*. 131
PLEISTOCENE LIZARDS FROM SAN JOSECITO CAVERN, MEXICO, WITH DESCRIPTION OF A NEW SPECIES. By *Bayard H. Brattstrom* 133

HERPETOLOGICAL NOTES

An addition to the list of pallid animals occurring in White Sands National Monument. By *Philip W. Smith* 135
Observations on the blue-tailed skink, *Eumeces fasciatus*, captured in Rondeau Park, Ontario and kept in captivity over winter. By *W. W. Judd* 135
Polydactylism in a second species of Amphibia in Muskee Lake, Colorado. By *Willard N. Rosine* 136
An anomaly in the venous system of a mature frog, *Rana grylio*. By *Willard N. Rosine* and *Paul F. Brande* 136
Four records of the Atlantic ridley turtle, *Lepidochelys kempi*, from Nova Scotian waters. By *Sherman Bleakney* 137
Unusual item of food for the gophersnake *Pituophis catenifer*. By *Mary M. Erickson* 137
The chorusfrog *Pseudacris brachyphona* in North Carolina. By *Albert Schwartz* 138
Small herpetofauna from the Pleistocene of Carpinteria, California. By *Bayard H. Brattstrom* 138
Rattlesnake hybrids: *Crotalus viridis* × *Crotalus scutulatus*. By *Sherburne F. Cook, Jr.* 139
A record of the northern pinesnake, *Pituophis melanoleucus melanoleucus*, from Alabama. By *Ralph L. Chermock* 141
Range extension of the whiptailed lizard *Cnemidophorus neomexicanus*. By *John F. Lawrence* 141
Systematic status of the Key West spadefoot toad, *Scaphiopus holbrooki albus*. By *William E. Duellman* 141
The lizard *Eumeces anthracinus* in Central Virginia. By *Sam R. Telford, Jr.* 143
A further range extension of *Gyrinophilus p. porphyriticus*. By *Gordon Thurow* 143
Fall and winter food of *Plethodon dorsalis* in Johnson County, Indiana. By *J. Alan Holman* 143

ICHTHYOLOGICAL NOTES

Color variation in certain marine fish eggs. By *Grace L. Orton* 144
The ribbed sculpin, *Triglops nybelini*, in Spitsbergen waters. By *Vladimir Walters* 145
Snake-eels as pseudoparasites of fishes. By *Vladimir Walters* 146
Melamphaes triceratops, a synonym of the deep-sea fish *M. anthrax*. By *Marion Grey* 147
Occurrence of the lancet fish, *Alepisaurus ferox*, in the Gulf of Mexico. By *Giles W. Mead* 148
First record of the mullet *Mugil liza* from Florida. By *H. P. Mefford* 149
Egg production of the fish *Hadropterus sciurus apristis* in San Marcos River, Texas. By *William H. Brown* 149
Notes on the capture of young sailfish and swordfish in the Gulf of Mexico. By *Edgar L. Arnold, Jr.* 150
Additional records of two fishes, *Erimyzon sucetta kennerlyi* and *Hadropterus copelandi*, from southern Ontario, Canada. By *D. M. Scott* 151
The 2-3 intervertebral joint in the fish genus *Catostomus*. By *Edward M. Nelson* 151
Offshore records of the tripletail, *Lobotes surinamensis*, in the Gulf of Mexico. By *David K. Caldwell* 152
Observations on schooling juvenile tuna, *Euthynnus alletteratus*, in the Gulf of Mexico. By *Harvey R. Bullis, Jr.* 153
First record of the shovelnose sturgeon, *Scaphirhynchus platorynchus*, from the Tombigbee River, Alabama. By *Ralph L. Chermock* 154

REVIEWS AND COMMENTS—Fishes of the Marshall and Marianas Islands. Vol. I; by Leonard P. Schultz et al., *by L. F. de Beaufort:* 154.—Fischkrankheiten; by Dr. Phil. Wilhelm Schaeperclaus, *by John E. Bardach:* 155.—From fish to philosopher; by Homer W. Smith, *by Robert Rush Miller:* 155.—A study of the fauna of the brown shrimp (*Penaeus aztecus* Ives) grounds in the western Gulf of Mexico; by Henry H. Hildebrand, *by Robert Rush Miller:* 156.—The scientific paper. How to prepare it. How to write it; by Sam F. Trelease, *by Robert Rush Miller:* 156.

EDITORIAL NOTES AND NEWS—ASIH 1955 meeting, San Francisco: 157.—Univ. of Miami Marine Laboratory: 157.—Genus *Bombina:* 158.—News notes: 158.

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The Embryology of the Sergeant Major, *Abudefduf saxatalis*

EVELYN S. SHAW

ALTHOUGH brightly colored species of the family Pomacentridae are abundant in Bahama and Florida waters, few studies have been made on their embryonic development. Breder and Coates (1933) described the development of *Pomacentrus leucoris* (Gilbert), and Brinley (1939) described the development of *P. leucostictus* (Müller and Troschel). While the author was staying at the Lerner Marine Laboratory during January 1953, a number of gravid females of *Abudefduf saxatalis* (Linnaeus) were obtained. Embryonic development was studied and the gross morphological changes from fertilization through hatching are described herein. The abundance of adults and the ease with which embryos can be obtained make pomacentrids suitable for experimental study.

I wish to thank Dr. Charles M. Breder, Jr. for the opportunity of using the facilities of the Lerner Marine Laboratory at Bimini, Bahama Islands.

MATERIALS AND METHODS

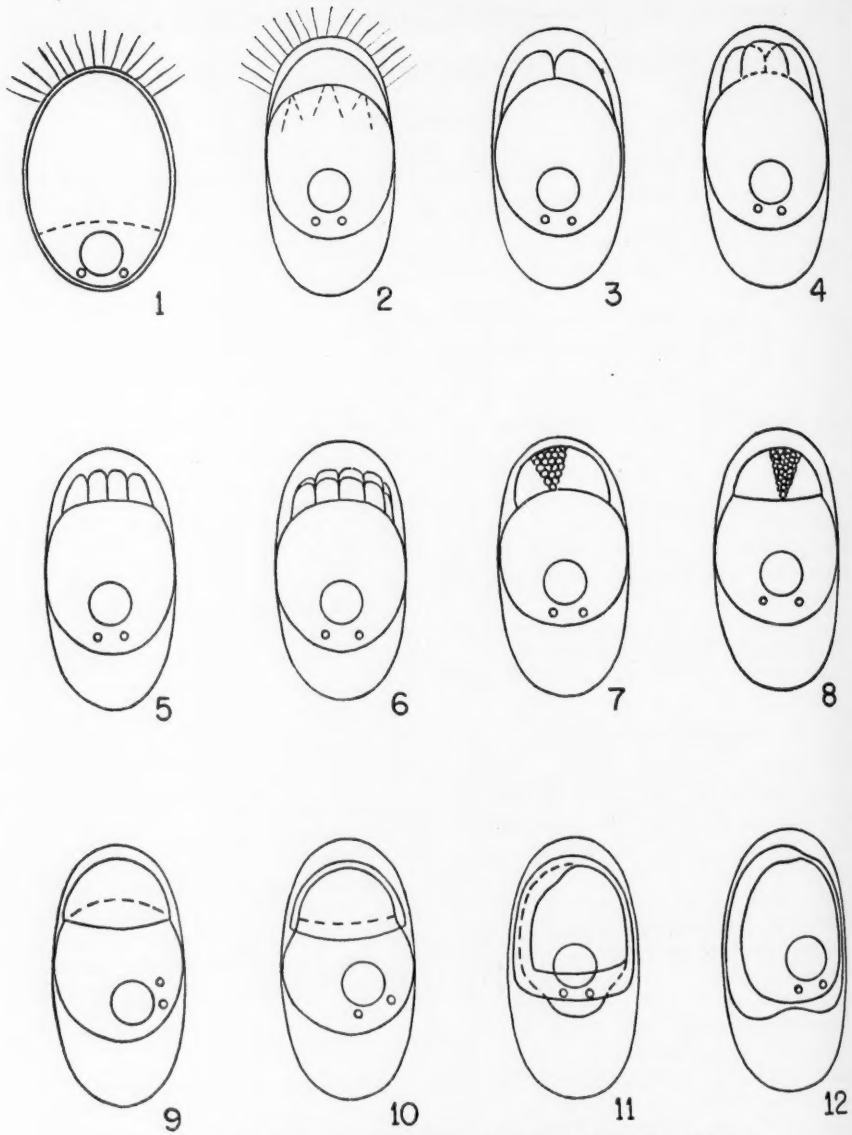
The sergeant major, *A. saxatalis*, can be observed readily near docks in Bimini Harbor and in the rocky areas of the open beach. When not in breeding condition they have alternating vertical yellow and black bars, and when excited assume an overall bluish-black hue. A number of adults approximately 5–6 inches long were observed darting in and out of crevices in the rocks, invariably returning to the same crevice from which they emerged. No pairs were observed spawning in the bay.

About 80 adults, ranging from 3½ to 6 inches, were caught by hook and line in Bimini Harbor. Sex was determined immediately by inspection of the genital region. A firm conical papilla, with a white tip, is extruded by the male, whereas the female has a soft, rounded genital papilla. The adults were divided into two groups for study. One group of 20 males and 20 females were put into outdoor aquarium pools for observation of their spawning behavior. (The pools, measuring approximately 6 ft. long, 4 ft. wide and 3 ft. deep, were made of concrete and had a steady flow of fresh sea water. Coral rocks were stacked in the pools with crevices large enough to shelter two fish simultaneously.) Three of the 20 females in this group were known to be gravid. Observations lasting for one-half hour were made four times a day for a two-week period. No spawning fish were noted, although four pairs exhibiting the darkened hue were seen swimming in and out of the crevices. The lack of spawning activity may have depended on the reported fact that the height of the spawning season comes in June, July and August. Dr. William Tavolga (personal communication) says that these forms were actively spawning during the summer months in aquaria at Marineland, Florida.

In the second group of about 40 fish, the sex was determined immediately after capture and they were placed in indoor aquaria according to sex. The eggs of gravid females were then stripped onto glass microscope slides, approximately 100 eggs on each slide. The slides were covered with sea water, and a sperm suspension, prepared by macerating two pairs of testes in sea water, was introduced. It was found that all males produced viable sperm. The water in the finger bowls was changed after the fertilization membrane appeared and 200 cc. of fresh sea water were added. The embryos were reared at 24°C and the sea water was changed twice daily. A total of six batches of eggs from six different females were studied for embryonic development.

EMBRYONIC DEVELOPMENT

Description of the Ovum.—The eggs are elliptical in shape, very similar to those reported in other pomacentrids (Breder and Coates, 1933; Brinley, 1939; Longley and Hildebrand, 1941). Fifty eggs averaged 0.95 mm. in length and 0.55 mm. in width. The size varies little in batches from different females. A thin chorion fits closely around the eggs and over it is a cap of adhesive material surrounding the animal pole. This cap is seen on ovarian eggs. Upon



Figs. 1–12. Early embryological stages of *Abudefduf saxatalis*. × 350.

Fig. 1. Unfertilized ovum. Fig. 2. Stage 1—Fertilized ovum, 60 minutes. (In subsequent stages, adhesive threads are not shown.) Fig. 3. Stage 2—Two-celled ovum, 75–80 minutes. Fig. 4. Stage 3—Four-celled ovum, 105 minutes, side view. Fig. 5. Stage 4—Eight-celled ovum, 130 minutes. Fig. 6. Stage 5—Sixteen-celled ovum, 155 minutes. Fig. 7. Stage 6—Early blastula, 5 hours. Fig. 8. Stage 7—Late blastula, 8 hours. Fig. 9. Stage 8—Early gastrula, 10 hours. Fig. 10. Stage 9—Later gastrula, 14 hours. Fig. 11. Stage 10—Yolk plug, 20 hours. Fig. 12. Stage 11—Neurula, 22 hours.

immersion into sea water, the cap opens outward and mushrooms out along the glass bottom, forming a type of holdfast. The cap is sticky at first and then hardens as the embryo develops. If it is removed from the substratum it will no longer adhere. In some instances the cap did not adhere to the substratum, but development was not impaired. The yolk color varies from deep red to amethyst, and a large lipoid globule surrounded by smaller ones is seen at the vegetal pole. The animal pole of the egg is proximal to the substratum and a thin layer of cytoplasm encases about two thirds of the yolk (Fig. 1).

Within three minutes after fertilization the chorion begins to lift away from the yolk. At the end of ten minutes the chorion is fully distended, measuring 1.2 mm. in length. This expansion does not occur unless the eggs are fertilized. The yolk at the vegetal pole becomes more granular in appearance, indicating that the cytoplasmic cover is pulling away and moving to the animal pole. The cytoplasm gradually accumulates at the animal pole, and at the end of an hour a high blastoderm is visible. Cytoplasmic strands can be seen radiating onto the yolk. The egg, which is centrally located in the expanding chorion, has become spheroid. In the six batches of eggs studied, 25 percent of the eggs developed and 10 percent hatched. Eggs stripped from a female 12 hours after the initial stripping were generally fragmented and did not develop.

Stage 1—Fertilized ovum, 60 minutes (Fig. 2). The high blastodisc can be seen at the proximal end of the egg.

Stage 2—Two-celled ovum, 75–80 minutes (Fig. 3). The first sign of cleavage in this (and in subsequent cleavages) occurs when the peripheral blastodisc exhibits irregularity. The disc then divides into two blastomeres.

Stage 3—Four-celled ovum, 105 minutes (Fig. 4). The second cleavage furrow is at right angles to the first, forming four blastomeres.

Stage 4—Eight-celled ovum, 130 minutes (Fig. 5). The third cleavage furrow, double and parallel to the first, divides the four blastomeres into a plate of eight cells.

Stage 5—Sixteen-celled ovum, 155 minutes (Fig. 6). The fourth cleavage furrow, double and parallel to the second, results in the formation of a plate of sixteen cells, four rows containing four cells each.

Stage 6—Early blastula, 5 hours (Fig. 7). The blastula, resulting from horizontal and vertical cleavages, is approximately five cells in depth.

Stage 7—Late blastula, 8 hours (Fig. 8). The blastula, now about 10 cells deep, forms a lenticular cap over the yolk. The entire ovum has become more spherical.

Stage 8—Early gastrula, 10 hours (Fig. 9). A peripheral band of cells, the germ ring, begins to migrate down over the yolk. This migration is equal at all points and there is no evidence of the accumulation of cells at any one point.

Stage 9—Gastrula, 14 hours (Fig. 10). The thickened lips of the germ ring have advanced over one-half of the yolk, constricting it; shield formation is indicated by a localized accumulation of cells.

Stage 10—Yolk plug, 20 hours (Fig. 11). The advancing germ ring has enclosed almost the entire yolk, leaving a small yolk plug extruding through the open blastopore; the embryonic shield is expanding anteriorly.

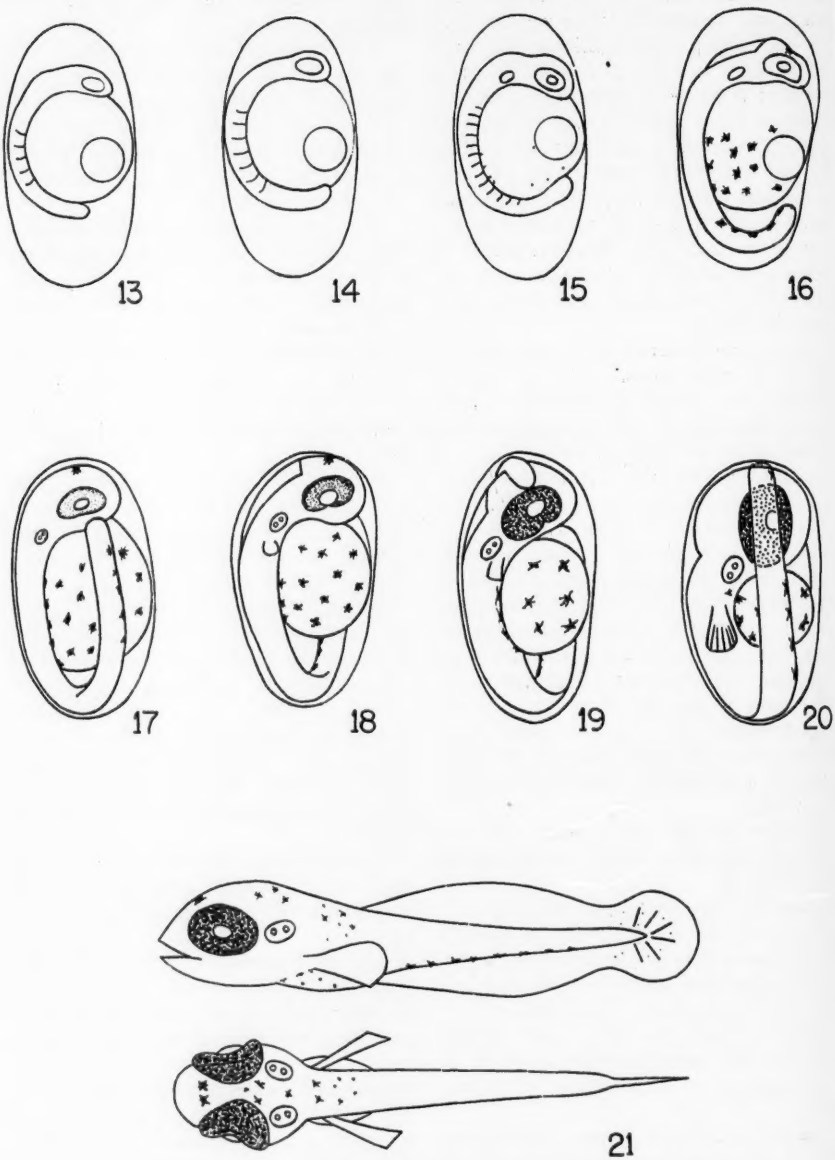
Stage 11—Neurula, 22 hours (Fig. 12). The entire yolk is enclosed in the extra-embryonic membrane. The shield, a conspicuous thickened mass, contains the neural keel.

Stage 12—Optic vesicles, 25 hours (Fig. 13). A small head-fold lifts the cephalic end of the embryo from the yolk, and a pair of optic vesicles are seen. Three or four somites are visible in the mid-body region; a tail thickening is present.

Stage 13—Brain constrictions, 28 hours (Fig. 14). Five or six somites are present when the three primary regions of the brain become apparent.

Stage 14—Pigmentation, 35 hours (Fig. 15). Small, dot-like melanophores have appeared on the yolk sac epithelium. Occasionally a few are seen on the ventro-lateral edge of the trunk. A lens has formed in the eye; the auditory vesicle is present and the mesencephalon has deepened. Twelve to thirteen somites and a small tail bud are visible. The embryo has moved away from the proximal end of the chorion and is found in the center, equidistant from both poles.

Stage 15—Motility, 44 hours (Fig. 16). The somites have become myotomes and slow, twitching movements of the tail are visible. A heart-beat is discernible beneath the left side of



Figs. 13–21. Late embryological stages of *Abudefduf saxatalis*. × 350.

Fig. 13. Stage 12—Optic vesicles, 25 hours. Fig. 14. Stage 13—Brain constriction, 28 hours. Fig. 15. Stage 14—Pigmentation, 35 hours. Fig. 16. Stage 15—Motility, 44 hours. Fig. 17. Stage 16—Retinal pigment, 60 hours. Fig. 18. Stage 17—Iridiophores, 66 hours. Fig. 19. Stage 18—Eyes mobile, 96 hours. Fig. 20. Stage 19—Jaws mobile, 120 hours. Fig. 21. Stage 20—Hatching, 155–160 hours.

the head. Two stellate melanophores, characteristic in all the *A. saxatalis* embryos, can be seen on the mesencephalon, and stellate melanophores are oriented along the ventro-lateral edge of the tail. The embryo is 1.3 mm. long.

Stage 16—Retinal pigment, 60 hours (Fig. 17). The embryo has increased considerably in length, measuring 2.5 mm. The head has deepened and enlarged and the embryo fills the entire chorion. Pigment cells are more numerous over the yolk-sac; light retinal pigment can be seen in the eye. Otoliths have appeared in the auditory vesicle. The embryo is able to rotate itself, and in many embryos the head is visible at the distal end of the chorion.

Stage 17—Iridiophores, 66 hours (Fig. 18). Blood corpuscles are clearly visible throughout the body and in the Duct of Cuvier. The eye pigment has become more dense and iridiophores appear on the trunk between the auditory vesicle and the anal region. A small pair of pectoral fin buds are present and the caudal fin anlage, a narrow membrane, is visible. The embryo is 2.9 mm. in length.

Stage 18—Eyes mobile, 96 hours (Fig. 19). The eyes are capable of turning in several directions and the retinal pigment has become concentrated and opaque. Melanophores on the yolk-sac are dendritic rather than stellate. The head is steadily enlarging and the yolk-sac is decreasing. The embryo is 3.1 mm. long. The mouth is a thin ventro-medial slit.

Stage 19—Jaws mobile, 120 hours (Fig. 20). The head of the embryo has shown a marked increase in growth while the total length still remains 3.1 mm. The jaws are mobile and the mouth irregularly opens and closes. The embryo is still able to rotate in the chorion.

Stage 20—Hatching, 155–160 hours (Fig. 21). The chorion softens gradually when the time of hatching approaches; it can be broken easily with a glass capillary tube. The embryos are quiescent in the narrow confines of the chorion. A break appears at the distal end of the chorion and the head of the embryo emerges. Some embryos which started to hatch tail first were unable to hatch fully, although a number did succeed. After hatching, the embryo is able to swim upward in the medium. The larvae swim intermittently with short, darting movements and then come to rest at the bottom. They are 3.2 mm. long and caudal fin rays are visible. Hatched larvae lived for three days in the laboratory. Efforts to keep them alive longer by varying the environmental conditions, such as food, population density, or sea-water concentration, were unsuccessful.

In summary, the gross morphological development of *A. saxatalis* is described. The ovum is similar in shape to that of other pomacentrid species. The embryos hatch between 155 and 160 hours after fertilization when they are reared at 24°C. Development conforms to the typical teleost pattern.

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Department of Animal Behavior, The American Museum of Natural History, New York 24, N. Y.

Hadropterus pantherinus, A New Percid Fish From Oklahoma and Arkansas[1]

George A. Moore and Jones D. Reeves

FIVE different expeditions to the Little River System of southeastern Oklahoma and southwestern Arkansas have each yielded specimens of an apparently new species of the genus *Hadropterus* Agassiz[2]. The first specimen was taken in 1927 (UMMZ 81185, see below)

[1]Contribution from the Research Foundation and No. 173 from the Zoology Department of the Oklahoma Agricultural and Mechanical College, Stillwater.

[2]Since this paper went to press, the genus *Hadropterus* was merged with *Percina* Haldeman; see Bailey, Winn and Smith, 1954, Proc. Acad. Nat. Sci. Phila. 106: 109–64.

and was provisionally reported by Hubbs and Ortenburger (1929b) as *Hadropterus macrocephalus* (Cope) and later catalogued as *H. maculatus* (Girard). These writers recognized the need for further study of Oklahoma and Arkansas *Hadropterus*. Hubbs and Raney (1939) indicated that *H. maculatus* is probably a complex of subspecies, an observation which we feel can prove to be correct. We propose the name *Hadropterus pantherinus*, suggested by Dr. Carl L. Hubbs, to accommodate this near relative of *H. maculatus* from the Little River System of Oklahoma and Arkansas. We are indebted to Dr. Hubbs for permission to describe this species which he has long recognized as new.

In connection with materials examined and in disposition of specimens, the following abbreviations are used: OAM, Oklahoma Agricultural and Mechanical College; UMMZ, University of Michigan Museum of Zoology; and MCZ, Museum of Comparative Zoology (Harvard College).

***Hadropterus pantherinus*, sp. nov.**

Plate I

Leopard darter

TYPES.—The holotype (Pl. I), UMMZ 167120, is an adult female 63 mm. in standard length collected by Moore and Reeves in Little River west of Pickens, Pushmataha County, Oklahoma, in Sec. 1, T2S, R20E, on March 25, 1951.

The fourteen paratypes bear the following data with the number of specimens followed by size ranges, museum numbers, locality, and date, in that order: 1 (59 mm.) UMMZ 81185, University of Oklahoma Museum of Zoology Expedition, tributary of Mountain Fork River in Polk County, Arkansas, June 29, 1927; 1 (38 mm.) OAM 2559, Moore and class in Mountain Fork River in Beavers Bend State Park in Sec. 10, T5S, R25E, McCurtain County, Oklahoma, August 21, 1948; 3 (22–27 mm.) UMMZ 167122, Frank Bernard Cross and Moore at the same locality, May 30, 1948; 1 (35 mm.) Tulsa University collections, Albert P. Blair in Little River south of Honobia (Honubbe) in Sec. 30, T1N, R22E, LeFlore County, Oklahoma; 1 (41 mm.) MCZ 38491, Carl. C. Rigney and Moore in the Mountain Fork River at Smithville, Sec. 13, TIS, R25E, in McCurtain County, Oklahoma, on August 17–19, 1948; 6 (48–72 mm.) UMMZ 167121, Moore and Reeves at the type locality on March 24, 1951; and 1 (52 mm.) OAM 4948, Reeves and Moore in Glover River in Sec. 13, T3S, R22E in McCurtain County, Oklahoma, March 25, 1951.

DIAGNOSIS.—A species closely related to *Hadropterus maculatus* from which it differs as follows (data for *H. maculatus* in parentheses): more scales in the lateral line, 81 to 94 (62–77); scales between spinous dorsal origin and the lateral line averaging 10.7 (8.04) with extremes of variation 9–13 (7–10); scales between anal origin and lateral line averaging 17.2 (11.6) with extremes of variation 16–19 (9–15); scales around the caudal peduncle 31.5 (24.3) with extremes of variation 31–32 (22–30); and color pattern with lateral blotches round or deeper than long (seldom round, usually longer than deep).

RELATIONSHIPS.—Although *H. pantherinus* is not as closely related to *H. macrocephalus* as to *H. maculatus*, the differences between *pantherinus* and *macrocephalus* are pertinent in this connection. *H. macrocephalus* was described by Jordan and Evermann (1896) as having incompletely scaled cheeks and opercles, a naked breast, 9 confluent black lateral blotches, above which there is a light wavy line, and an incomplete lateral line. We feel that the specimens forming the basis of this description may have been a complex of forms, since specimens of *macrocephalus* examined by us have the cheeks and opercles naked. In contrast, *H. pantherinus* has the cheeks, opercles, and breast well invested with scales, those on the cheeks embedded. *H. macrocephalus* further differs from *pantherinus* in having a conspicuous black spot at the origin of the spinous dorsal (less intense, but perceptible, in adults); a wavy light line bordering the lateral band, which is broad and with expansions where the blotches occur; and the lack of discrete round blotches—rather, each scale of the dorsum usually has its posterior half covered with small melanophores. UMMZ 154701 has 2 elongated blotches anterior to the spinous dorsal.

Hubbs and Raney (1939) and Bailey (1941) stated that the distance from the insertion of the pelvic fins to the union of the gill mem-

Adult female holotype, 63 mm. in standard length, of *Hadropterus pantherinus*.

branes, in *H. macrocephalus*, is contained 0.8 to 1.2 (our data 0.8 to 1.1) times in the distance from the union of the gill membranes to the tip of the mandible. This value in *H. pantherinus* ranges from 0.55 to 0.82.

DESCRIPTION OF TYPES.—The characters of the holotype are followed, in parentheses, by the limits of variation in meristic characters and proportional measurements of all the paratypes. The scales are small: 11(9–13) from spinous dorsal to lateral line; 90 (83–94) in the lateral line; 16 (15–19) from anal origin to lateral line; and 32 (31–32) around the caudal peduncle. The cheeks and opercles are completely invested with exposed or imbedded scales. The nape is naked or has embedded scales. A small patch of scales or a single large scale lies between the pelvic fin bases. The fin-ray counts are as follows: D. XIV–12 (XIV to XVI–11 to 14); A. II, 9 (II, 9 to 11); P_1, 14–14 (13–13 or 14–14); P_2, I, 5 in all; principal caudal rays 17 (16 or 17); head in standard length 3.7 (3.2–3.7); head depth at occiput in standard length 7.6 (6.9–7.7); head depth in head length 2.0 (2.0–2.2); upper jaw in head 2.8 (2.8–3.2); orbit in head 4.7 (3.4–4.8); eye in head 5.0 (4.0–5.7); bony interorbital width in snout (adults only) 3.2 (2.5–3.3); postorbital length of head in head 1.8 (1.8–2.0); snout in head 3.5 (3.5–4.7); snout in orbit 0.75 (0.97–1.3); and least depth of caudal peduncle in head length 3.5 (3.3–4.4).

COLORATION.—The following color description was taken principally from freshly killed paratypes. The dark iris is conspicuously marked with gold-colored flecks. Jet-black bands extend from the eyes through the nostrils to cover the premaxillae for their full length, but diminish in intensity on the posterior two-thirds. The brownish parietal spot is shaped like a disk with a small anterior portion removed. A median faint, light line crosses the upper lip and separates the two preorbital bands. The subocular bar is slightly inclined backward (less evident in half-grown examples and absent in young). The background color of the back is pale olive; underparts immaculate and with a yellowish-olive tint which is soon lost in the young after fixation, leaving the specimens quite white. The vertically elongated caudal spot is indistinct in adult males, but conspicuous in young and females. The spinous dorsal fin has olive rays with alternating checks and the interradial membranes are intensely black on their basal halves anteriorly, but this diminishes in intensity backward. There are no bright colors, other than black, on the interradial membranes of any fins. The soft dorsal rays are similar to the spines in color, but much paler and never have pigment on the rays which are bordered by files of fine black dots. Conspicuous markings are absent on the caudal fin but rows of melanophores appear along the pale olive fin rays in greatest intensity on the outer principal rays. The anal and pelvic fins are white with scattered melanophores on the interradial membranes. The pectoral fins are clear except for melanophores in single files along the fin rays. The distinctive lateral band consists of 10 or 11 circular black spots rather broadly connected by a fainter black band overlaid by an olive-yellow hue. Eleven to 13 squarish dorsal blotches, mesially broken in two in the region of the spinous dorsal, mark the back. Between the dorsal and lateral series there is an irregular row of smaller blotches, occasionally doubled anteriad. The dorsolateral spots are discrete and round in the young to half grown and in females, but poorly defined in adult males. On a half-grown specimen the background color is very pale, but the scales are outlined with a reddish tint. The underparts of the same specimens are white. A sharply defined black streak marks the midventral line of the caudal peduncle and extends anteriad on each side of the anal base.

DISTRIBUTION AND HABITAT.—The species is known only from the Little River System, of which the Mountain Fork River is a tributary. These streams are clear, except at flood stage, and flow over beds of boulders, coarse gravel, and some sand. The new species is believed to be restricted to the upper swifter portions of the river system, since intensive collecting in the lower reaches of the Mountain Fork and in Little River near the Arkansas-Oklahoma boundary failed to yield any specimens. It is significant that *Hadropterus maculatus*, which has not been taken with *H. pantherinus*, occurs in small numbers in the lower portions of Little River near the Oklahoma-Arkansas state line. The presence of *H. maculatus* in the same river system and the absence of intergradation are regarded as further convincing evidence that the two forms are fully differentiated. The types taken by us were found in rather

swift gravelly riffles. *Hadropterus scierus* Swain, *Hadropterus phoxocephalus* (Nelson), and *Hadropterus copelandi* (Jordan) are the only other members of the genus known to occur with the new species. Other darters associated with *H. pantherinus* include *Etheostoma radiosum radiosum* (Hubbs and Black) and *E. nigrum nigrum* Rafinesque.

DISCUSSION.—*Hadropterus pantherinus* apparently has evolved in response to isolating mechanisms in which extreme turbidity of the Red River coupled with the numerous long and deep pools, of frequent occurrence in Little River, doubtless played an important role. Another possible explanation is that it represents a relict race that formerly enjoyed a wider distribution but is now facing extinction.

H. pantherinus and several forms of *Etheostoma*, being inhabitants of clear swift tributaries, have remained quite isolated for long periods of time. In contrast, mud-loving species such as *Etheostoma proeliare* (Hay), *Etheostoma gracile* (Girard), and *Etheostoma chlorosomum* (Hay), widely distributed in southeastern Oklahoma, are not restricted to either the Red or Arkansas river systems, and form apparently undifferentiated and more widely distributed populations.

MATERIAL EXAMINED

Through the courtesy of Drs. R. M. Bailey and R. R. Miller we have had an opportunity to compare the new species with related forms as indicated below. Unless otherwise stated the specimens examined are *Hadropterus maculatus*. UMMZ numbers are followed, in parentheses, by the number of specimens.

ALABAMA.—Glass Mill Cr., 5 mi. north of Maroyn: 123924 (1). Opintlocco Cr., 3 mi. southeast of Tuskegee: 123985 (1). Benton, Lowndes County: 111240 (Metal tag) (1).

ARKANSAS.—Fourche la Fave River, 9 mi. south of Waldron, Scott County: 81186 (1). Little War Eagle Cr., Madison County: 123112 (1). Cache R., Lawrence-Craighead County line: 123637 (2). Frog Bayou, Crawford County: 127757 (1). Bodeau Cr., Lafayette County: 128207 (1). Frog Bayou, Crawford County: 128414 (1).

KENTUCKY.—Rockcastle R. or Parker Branch: 96945 (7). Peters Cr., on U. S. Highway 31 E, Barren County: 154700 (11). *Hadropterus macrocephalus* (same locality): 154701 (1).

OKLAHOMA.—Ten mile Cr., Pushmataha County: 109032 (1). Poteau R., LeFlore County: 127229 (1). Same locality: 127266 (3). Poteau R., Slate Ford, LeFlore County: 137915 (3).

ONTARIO, CANADA.—Tributary Thames R. west of Thamesville: 89014 (56).

VIRGINIA.—North Fork, Holston R., Smyth County: 119678 (3). *Hadropterus notogrammus*, North R., Rockbridge County: 144697 (3). *Hadropterus macrocephalus*, North Fork, Holston R., above Saltville: 96879 (3).

WEST VIRGINIA.—*Hadropterus macrocephalus*, Elk R., 9 mi. below Ivy: 119637 (1).

WISCONSIN.—Thornapple R., Rusk County: 95884 (60).

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The Development of the Gas Bladder in the Green Sunfish, *Lepomis cyanellus*[1]

ARTHUR EDWARD DUWE

IT has been noted in the literature that the gas bladders of some closely related species of fishes have different origins, and also that such species may have structurally different definitive bladders. Among some related fishes one species may possess a gas bladder while another lacks it.

Vogt (1842) studied the development of

[1] Contribution from the Department of Zoology and Entomology, Ohio State University.

Coregonus palaea and determined that the gas bladder originates from the esophagus as a solid mass whose cells are at first very much like those of the intestine. Within this mass a cavity later appears which establishes communication with the esophagus. On the other hand, Price (1935) stated that in *Coregonus clupeaformis* the gas bladder does not arise until after hatching. In a later personal communication, Dr. Price stated that in postlarvae of this species the gas bladder arises as a dorsal diverticulum from the foregut. This observation agrees with what I noted in the rainbow trout.

The above citations illustrate the variations in the mode of origin of the gas bladder that may occur within a single genus, i.e., *Coregonus*.

Hoar (1937) wrote that a part of the air bladder of the Atlantic salmon, *Salmo salar*, originates as a solid mass of mesodermal cells dorso-lateral to the gut. Later an epithelial evagination of the gut invades this mass and forms a tube lined by a syncytium whose cells are columnar at the posterior end. Presumably such an air bladder has a lining of endodermal origin, surrounded by tissues in its walls of mesodermal derivation.

In a study (Duwe, 1952) of the origin of the gas bladder in the bluegill, *Lepomis macrochirus*, the gut was found to lie on the embryo's left side and the gas bladder diverticulum evaginated from the right side of the gut toward the midline of the embryo. In this species the pneumatic duct and *rete mirabile* are transient structures, the duct becoming completely obliterated and the *rete* so reduced as to render its function doubtful. In the definitive condition the gas bladder comes to lie dorsal to the gut.

A summary of the literature indicates that fishes can be placed in four categories based on the structure and the presence or absence of the gas bladder. There are those which have two- or three-chambered bladders, carp and suckers respectively, and a duct of communication with the gut which is designated the pneumatic duct. These gas bladders are referred to as the physostomous type. A second group consists of those fishes which have a single-chambered gas bladder which also is connected to the gut by a pneumatic duct. This type, also designated as physostomous, is found in the sturgeon, salmon, trout and pike. A third type, called physoclistous, is characterized by a single-chambered gas bladder without a pneumatic duct in the adult fish. Representatives having this type are the perch and the Centrarchidae, which include the bluegill and green sunfish. A fourth category comprises those fishes which have no gas bladder as adults, and could be referred to as aphysal. The darters generally are in this group.

In the specialized physoclists, as, for example, the bluegill, it is possible to trace, at least in part, a phylogenetic recapitulation of the more primitive physostomous type. At first, a diverticulum from the gut gives rise to a pneumatic duct and a gas bladder. In later developmental stages, specializations occur such as the atrophy of the pneumatic duct, the development of the gas gland, and the appearance of a *rete mirabile*.

As to their mode of origin, gas bladders arise in one of three ways: (1) As a diverticulum from the gut; (2) As a solid mass of mesodermal cells which later is invaded by an endodermal evagination from the gut; and (3) As a solid mass of cells originating in the region of the esophagus and in which later appears a cavity communicating with the esophagus.

No direct correspondence appears to exist between the modes of origin of the gas bladder in different fishes and the definitive condition in the adult.

It is known that either physostomous or physoclistous fishes may have gas bladders originating as diverticula from various places on the gut, Type 1. It is also known that in certain physostomous types the gas bladder arises as a solid clump of cells, Types 2 or 3. It remains for the present writer to demonstrate a case of a physoclistous type of gas bladder arising as a solid mass of cells, a modification of Type 3 above.

Embryos and adults of *Lepomis cyanellus* Rafinesque were studied. Embryos of the rainbow trout (*Salmo gaerdneri*) and bluegill were examined as comparative material, as were adult golden red-horse suckers (*Moxostoma erythrurum*).

The green sunfish embryos used in this study were reared by the writer in the laboratory. When males were observed to be nest-building, collecting was started. On obtaining gravid females, eggs were stripped into petri

dishes containing one fourth inch of distilled water. The milt was then stripped into the dishes immediately and the contents swirled around with a fine brush.

It was found that the fewer the number of embryos per dish the lower was the mortality rate. Usually thirty embryos were kept in a dish and water was added at intervals to keep the level at one fourth inch. Embryos were easily handled with wide-mouthed pipettes. The water temperature, measured at various intervals day and night, fluctuated between the extremes of 78° and 83°F.

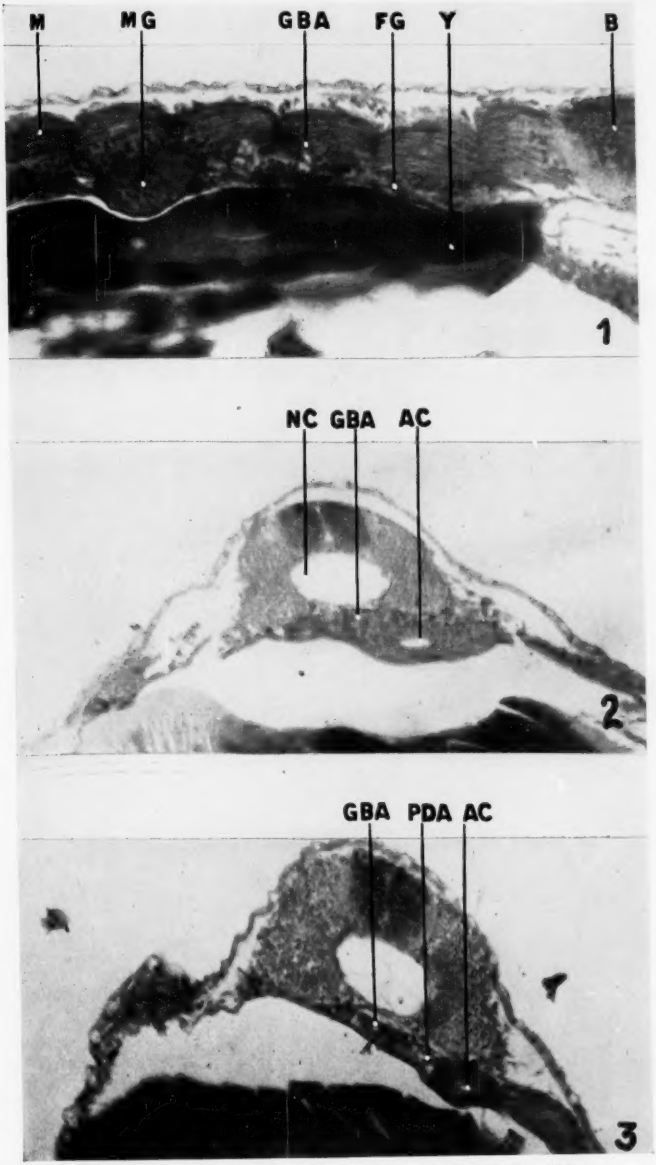
Embryos were fixed in Bouin's at intervals varying from three to twelve hours. The specific hours of incubation before fixation were as follows: 47, 50, 53, 57.5, 64.5, 68, 72, 81, 90, 100, 104.5, 114.5, 120.5, 127, 136, 144, 152, 160, 168, 176, 184, 196, 208, 217, 220, 232, 244, 256, 268, 280, and 292, at which time all yolk had been absorbed. Embryos were imbedded in paraffin and sections cut at eight microns. Sagittal sections were made of all stages; transverse sections of the critical stages only. Staining was in Mallory's phospho-tungstic acid hematoxylin. Dissections were made of adult green sunfish and the nervous and vascular elements of the gas bladder were traced. The gas gland and *rete mirabile* of several green sunfish were sectioned at ten microns and stained with hematoxylin and eosin.

The green sunfish develops a physoclistous type of gas bladder. Between seventy-eight and one hundred forty-four hours of development it is clearly of the physostomous type (Pls. I-III).

The first indication of a developing gas bladder occurs at fifty hours as a clump of undifferentiated cells lying to the right of the gut which is displaced to the left of the midline of the embryo (Pl. I, Figs. 1 and 2). This mode of origin is in sharp contrast to that usually ascribed to both the physostomous and to the physoclistous fishes, wherein the gas bladder is generally regarded as originating as a diverticulum of the foregut. For example, the present writer has observed this latter mode of origin in the rainbow trout, a physostomous fish, and also in the bluegill, a physoclistous fish. Inasmuch as the bluegill and the green sunfish are members of the same genus, it is of considerable interest that these two closely related species develop their gas bladders in distinctly different ways. However, differences in the manner in which corresponding structures develop in different fishes of the same genus have been noted above. Hence, the findings reported in this paper are not inconsistent with conditions reported elsewhere, nor wholly unexpected.

With the clump of undifferentiated cells, the anlage of the gas bladder, established at fifty hours, the pneumatic duct anlage next develops, between sixty-eight and seventy-eight hours of incubation. In its first manifestation the duct consists of cells growing out from the cell mass of the gas bladder anlage in such a way as to form cell strands which connect with the ventral and dorsal margins of the foregut (Pl. I, Fig. 3). Between the points of junction of the cell strands and the gut, a small outpocketing of the gut occurs (Pl. II, Fig. 4). This outpocketing probably is a result of mutual interaction between the cells of the pneumatic duct anlage and the cells of the gut, and does not persist beyond the stage when it appears. By the next stage the gut wall at this point has perforated, and thus has brought about the confluence of the lumena of the gut and the pneumatic duct. Further alignment of the cells of the gas bladder, at the point of origin of the cell strands of the pneumatic duct anlage, results in continuity of the lumena of the gut, pneumatic duct, and gas bladder (Pl. II, Fig. 5). The continuity of the lumena of these three structures does not persist however and by the next stage the pneumatic duct becomes separated from the gas bladder but retains its continuity with the gut (Pl. II, Fig. 6). The pneumatic duct retains its open lumen from seventy eight hours through one hundred fifty-two hours of development, after which time it closes completely (Pl. III, Fig. 7), and is retained thereafter only as an anterior ligament extending from the gas bladder to the esophagus (Pl. III, Fig. 8). In the definitive condition, the artery, vein, and nerve of the gas bladder are found in this anterior ligament.

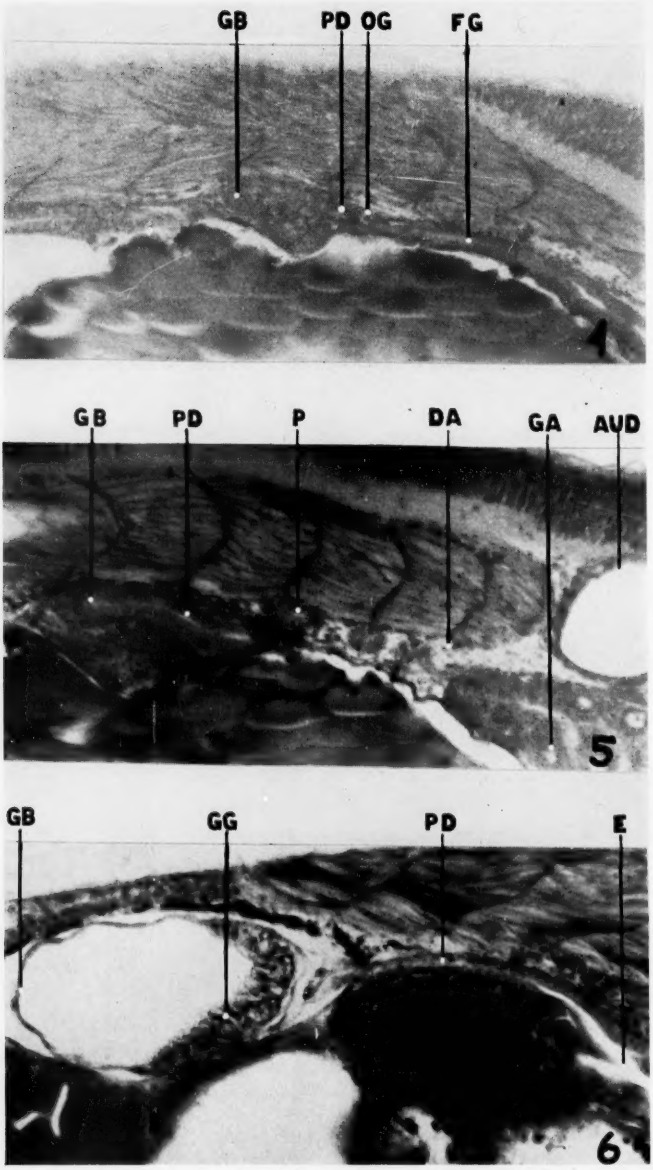
The gas gland in its development at the anterior end of the gas bladder is first composed of columnar cells (Fig. 6). Later, its cells be-



Photomicrographs of *Lepomis cyanellus*. Magnification 180×

Fig. 1. A sagittal section through the gas bladder anlage at 50 hours of development.
Fig. 2. A transverse section through the gas bladder anlage at 50 hours of development.
Fig. 3. A transverse section through the gas bladder anlage at 68 hours of development.

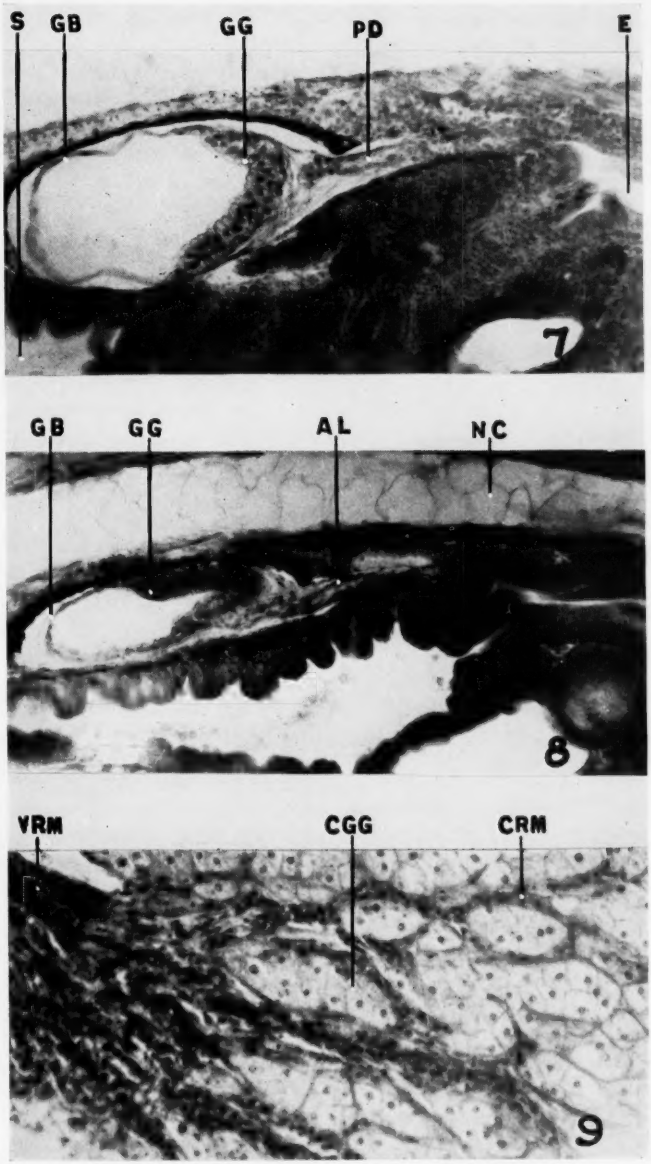
AC, alimentary canal; B, brain; FG, foregut; GBA, gas bladder anlage; M, myotome; MG, midgut; NC, notochord; PDA, pneumatic duct anlage; Y, yolk.



Photomicrographs of *Lepomis cyanellus*. Magnification 180×

Fig. 4. A sagittal section through the gas bladder at 78 hours of development.
Fig. 5. A sagittal section through the gas bladder at 81 hours of development.
Fig. 6. A sagittal section through the gas bladder at 144 hours of development.

AUD, auditory vesicle; DA, dorsal aorta; E, esophagus; FG, foregut; GA, gill arch; GB, gas bladder; GG, gas gland; OG, outpocketing of gut; P, pronephric tubule; PD, pneumatic duct.



Photomicrographs of *Lepomis cyanellus*. Magnification 180×

Fig. 7. A sagittal section through the gas bladder at 152 hours of development.
Fig. 8. A sagittal section through the gas bladder at 232 hours of development.
Fig. 9. A frontal section of the gas gland and *rete mirabile* of an adult green sunfish.

AL, anterior ligament; CGG, cell of gas gland; CRM, capillary of *rete mirabile*; E, esophagus; GB, gas bladder; GG, gas gland; NC, notochord; PD, pneumatic duct; S, stomach; VRM, blood vessel of *rete mirabile*.

come cuboidal, (Fig. 7), and still later squamous, (Fig. 8), the latter condition being definitive.

The *rete mirabile* consists of a dense network of branching and anastomosing capillaries coursing between the cells of the gas gland (Pl. III, Fig. 9). A branch of the vagus nerve runs to the gas gland.

The green sunfish thus becomes equipped with a physoclistous type of gas bladder which, during its development, recapitulates in part the physostomous type of gas bladder, which originates not as a diverticulum of the foregut but as an independent solid mass of undifferentiated cells.

To the author's knowledge, this is the first demonstrated instance of a physoclistous type of gas bladder originating in the manner described above.

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Studies on the Life History of the Rosyface Shiner, *Notropis rubellus*[1]

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THE purpose of this paper is to present additional information about one of our common minnows, the rosyface shiner, *Notropis rubellus* (Agassiz). Field observations were made near Allegany, New York, over a period of four weeks from June 10 to July 3, 1941. During this time pre-spawning and spawning activities were observed. Scales from specimens collected before and during the breeding period were examined and the age and growth determined. Stomach analysis and egg counts were tabulated. Some observations on the hatching and growth of the young were also carried out.

Literature

Only the literature considered pertinent to the phases of the life history herein considered are reviewed. Hubbs and Lagler (1941: 56–7) gave the range of the rosyface shiner as follows: "From the Red River basin in North Dakota and from the northern border of Minnesota through the entire Mississippi River and Lake Michigan drainages of Wisconsin, and through most of Michigan and southern Ontario to the the St. Lawrence system (including Lake Champlain); southward on the east slope of the Appalachians from the Hudson River to the James River, and on the west to the New River basin of Virginia, the Ohio Valley north of the Cumberland division, and to Illinois and Iowa."

Greeley (1929: 171–2; 1930: 80) stated that the rapids of larger creeks and streams are the usual habitat of *N. rubellus*. Osburn (1901: 58) noted that ripe females were observed in schools over clear gravelly places on riffles. Hubbs and Brown (1929: 36) wrote "mid-water" and "well off the bottom" as the breeding place. Hankinson (1932: 417) reported that spawning took place a few inches above gravel. Raney (1938: 41[2]; 1940a: 7; 1940b: 361) observed that the nests of *Hybopsis (Nocomis) micropogon* are a common spawning place for *N. rubellus*. He made these observations in the Allegheny River, French Creek and Catatonk Creek, New York. Greeley (1938: 67) observed breeding males above the nest of a river chub.

[1] Abstracted from a doctoral thesis prepared under the direction of E. C. Raney of Cornell University, 1947.

According to the literature, spawning takes place in the spring and early summer. Osburn (1901: 58) observed schooling females with ripe eggs on May 24, 1898. Forbes and Richardson (1909: 154) made similar observations, stating that females are ready to spawn in the latter part of May. Bean (1915: 351) reported ripe females on July 20, 1914. Greeley (1938: 67) wrote that "a breeding aggregation consisting of twenty or more highly colored males was noted in lower French Creek May 25." Adams and Hankinson (1928: 354) reported *Notropis rubellus* in breeding color and with nuptial tubercles on June 22, 23, and 27, and July 21, in 1916.

Locality and Ecology

The spawning of *N. rubellus* took place in Five Mile Creek, a small tributary of the Allegheny River, in Cattaraugus County, near Allegany, New York. The lower two miles of the stream consisted of a series of pools and riffles. The pools averaged between two and six feet deep, and between ten and sixty feet long. The width of the creek averaged about twenty feet. The bottom consisted of varying sizes of gravel, interspersed with some larger rocks, sand and some clay. In some places both banks were gravelly, sometimes they were of earth, and occasionally one side of the creek was lined with an earthen perpendicular bank, the opposite side by a flat, sandy and gravelly shore. The upper reaches of the stream passed through much open pasture and cultivated land, but as the creek neared the Allegheny River, its shores were crowded with trees and shrubs.

The fish most closely associated with *Notropis rubellus* is *N. cornutus chrysocephalus*, the common shiner. Both species were abundant in ten collections made in Five Mile Creek. Six of these collections contained hybrids between *Notropis cornutus chrysocephalus* and *Notropis rubellus*. Greeley (1938: 51) reported the hybrid between *N. cornutus* and *N. rubellus* to be common in the Allegheny and Chemung Rivers. Among the twenty-four additional species taken in these collections, *Campostoma anomalum anomalum* was the most common. Others taken frequently were *Pimephales notatus*[2], *Catostomus c. commersoni*, *Notropis deliciosus stramineus*, and *Semotilus a. atromaculatus*. The last four species occurred in seven of the ten collections. These associations were also found in collections made in eleven neighboring streams draining into the Allegheny River. With the exception of *N. d. stramineus*, Greeley (1938: 51) listed the other three forms as most common in the Allegheny drainage.

The site which the rosyface shiner chose for spawning activities lay about 200 yards upstream from where the creek enters the river. The scale studies, stomach analysis, egg counts and all other laboratory work were carried on in the Biology Department of St. Bonaventure's University, in Allegany, N. Y. The preserved collections from which these studies were made, are at Siena College, Loudonville, N. Y.

Sexual Dimorphism

The following descriptions were made from specimens in breeding condition after they had been in ten per cent formalin for several hours.

Male—The entire snout, lips, chin, branchiostegals, and top of the head as far as the nape are brick red. The opercle, the belly, and lower sides as far as the anal are a lighter red. The mid-dorsal line from head to dorsal fin is brick red, mixed with the usual dark color of this area. A dark line runs from the top of the eye to the upper angle of the opercle, around its posterior edge and then fuses with the base of the pectoral fins. A light red diffuses over the opercle, merging with a darker band of color at the posterior border. The basal two-thirds of the pectoral fins, the base and proximal halves of the pelvics, and the base of the anal fin are red. The basal portion of the dorsal fin is bright red.

Tubercles cover the snout and lower jaw, and a few are present on the upper half of the opercle. They also occur on the scales above and below the lateral line. The upper five or six pectoral rays have hook-shaped tubercles in single and double rows on the dorsal surface. The upper side of the pelvic fins, and the dorsal and anal fins also bear tubercles.

Female—The top of the head is light red, as are the edges of the lips and base of the pectorals. A faint red colors the belly from the branchiostegals to the pelvic fins. Tubercles occur on top of the head, on the opercle, cheek, back of and below the eye, as well as on the

[2] E. C. Raney, "The Distribution of the Fishes of the Ohio Drainage Basin of Western Pennsylvania" (Unpublished doctoral dissertation, Cornell University, 1938).

branchiostegals, mandible and a few on the dorsal scales.

Pre-Spawning Activities

The following activities were first observed on the morning of June 10, 1941, within the limits of two pools, an upper and a lower, separated by a small riffle. A riffle at the head of the upper pool proved to be the actual spawning site. Good observation was possible from an overhanging bank about six to seven feet high. Vision was aided by the use of polaroid sun glasses and field glasses.

A closely bunched group of *Notropis rubellus* was first noticed coming upstream along the left side of the upper pool. There were approximately one hundred in an oval-shaped school which was about four feet long and two and a half feet wide. The fore part of the school was mostly females, while the rear half was largely males. A few males could be seen among the females, and some females among the males. At times they were so closely bunched that they actually touched one another in swimming along, but usually they swam about one to two inches apart.

When the school reached the upper riffle it wheeled and turned downstream, coursing along the right side of the pool through the lower riffle into the lower pool. Upon reaching the lower limits of this pool, the school veered sharply and returned up the left side through the connecting riffle and again up the left side of the upper pool where they were first observed. Thus briefly, the course was from the upper pool to the lower pool along the right side of the stream, and from the lower pool to the upper pool along the left side. The first period of observation lasted four hours, during which the school paused occasionally at the sandy bank of the upper pool.

About a hundred yards downstream another school was observed pursuing the same activities. Here a similar movement pattern in a wide shallow riffle took place. This school did not have quite as definite a pattern as observed in the upstream area. At regular intervals the school passed up and down the riffle, following a circular route or weaving an irregular course from bank to bank. Several times it came close to the shore of the pools and hesitated momentarily. A sampling of the bottom at these points showed nothing.

Sometimes a small group of about fifteen or twenty broke away from the main body and carried on circling movements by themselves. The speed at which the schools moved was at all times uniformly swift. Within the school itself some individuals changed position, but more often they maintained their place. It was impossible to determine whether any one individual or whether several held a leading position. It seemed that three or four members consistently maintained forward positions.

These activities were observed for three successive days before heavy rains and consequent turbidity prevented further observation. Several days later when the stream cleared, the shiners pursued the same activites as before. A collection was made with a seine and both males and females were found to be ripe. A slight pressure on the abdomen caused the eggs to spurt forth, immediately adhering to the hand. They were reddish brown and about one and one-half to two millimeters in diameter. The milt was of the usual milky-white color. The temperature of the water on this day, June 19, was 71°F., and that of the air was 80°F.

During the next three days the coursing movement of the schools ceased and they maintained a stationary position immediately below the upper riffle. From this position, some rose to the surface and retrieved bits of material floating on the water. Others approached the low sandy shore and then returned to their position in the deeper part of the pool. Smith (1908: 12–5) described a circling movement upstream and downstream by *Chrosomus erythrogaster* when alarmed during spawning activities. He did not observe these movements previous to spawning.

Spawning Conditions and Activities

Actual spawning began on June 23, was discontinued the following day, resumed again on June 25 and continued every day until June 28. The number of spawning individuals was reduced daily until there were only ten fish on the last day. Water temperature on the first day was 76°F. It increased during the rest of the spawning period as follows: June 24, 79°; June 25, 80°; June 26, 81°; June 27, 82°;

and June 28, 84°F. The average temperature was 80.3°F. Hankinson (1932: 423) suggested a temperature of about 18°C. (64.4°F.) was suitable for the initiation of spawning activities for minnows of this type. Spawning took place during bright sunny days which allowed the water upstream to become warmed. The greater part of this upstream area was open, the bed and shores being gravelly.

The spawning site was in the shallow water to the right of the stream just below the upper riffle. The water on the left side along the opposite bank was about two to three feet deep. From here the bed of the creek sloped upward towards a shallow gravelly area of the right shore, over which flowed two to three inches of water. The stones ranged from one-half inch to five inches in diameter with an occasional one ten to twelve inches in diameter. In this area about eight to ten depressions from five to twelve inches in diameter were used repeatedly as "nests" by the spawning minnows. The common shiner, *Notropis cornutus*, favors such gravelly depressions for its breeding nests (Raney, 1940a: 4).

Two schools of *N. rubellus* lay in the pool just below the riffle, one in the deeper part, the other alongside the spawning site. This latter school suddenly dashed into the spawning area. In the rush some of the minnows were crowded out of the water and momentarily flopped about on top of protruding gravel stones. The school separated into four or five groups of eight to twelve minnows, each group coming to rest in a depression. Males and females then vibrated their bodies in unison, causing the water to break at the surface and literally to "boil." Both sexes crowded one another, the sides of their bodies in contact but scarcely holding one set position during the brief spawning act. There was some movement of the groups from side to side in the depression, and at times a forward and backward movement. No pairing of individuals was observed. Smith (1908: 12–5) reported similar spawning activities for *Chrosomus erythrogaster*. He observed the minnows crowding together in shallow water with much commotion, during which time individual action could not be determined.

This threshing and lashing about in the depressions lasted five or six seconds. Then followed a period of relative quiet for about thirty seconds, during which the minnows remained quiet in the depressions while a few moved to other nests. The brief period of vibrating and body shaking was repeated, followed again by a short period of quiet. These spawning and resting periods lasted about five minutes and then the school dashed back to their former position in the pool. After ten minutes the whole procedure began all over again with the sudden dash from the pool into the shallow waters of the spawning site. During the spawning period in the shallow waters, some groups were busily engaged in the breeding act, others lay quiet in the depressions. Once the movement out of the site began, the entire school left as one body. The movement into and out of the area was always accomplished swiftly and together.

When the spawning fish were cautiously approached by the author to within about five feet, the minnows quickly left the spawning bed. After about twenty minutes they returned, and from then on, the presence of an observer in no way deterred them from spawning.

At one time several stoneroller minnows, *Campostoma anomalum*, were seen among the spawning depressions, digging with their mouths among the sand and gravel in search of eggs. Although they remained there searching and feeding for several days, the spawning minnows did not seem to pay any attention to them. During the last three days of spawning, the group movement into and out of the site changed somewhat. The school was reduced to a few groups of eight to ten minnows. They no longer returned to the pool after the brief breeding act, but remained on the spawning grounds. From this position they moved into the depressions, much slower and with less threshing about, until finally all spawning activities ceased.

Chasing Activities

On various occasions during the days of spawning, an activity took place that was somewhat similar to the ceremonial behavior described by Reighard (1910: 1129) for the horned dace. Two minnows were observed to break away from the school in the spawning area, and side by side, dash swiftly through the water. Their movements were so swift that

it was impossible to determine whether a male and female, or whether two males were involved. One at least was a male because the characteristic red snout was easily discernible. With their bodies closely appressed, the snout of one reaching the pectoral fins of the other, they raced through the shallow waters of the spawning bed and out into the pool where they parted. The length of their courses averaged three to six feet, during which the pair never broke contact. Sometimes this activity took place while the school lay in the pool, the pair parting when they reached the shallow waters of the site.

Hankinson (1932: 417) made the following observation of breeding *N. rubellus:* "The male would collide with the females, striking them on or near the head with roughened snouts, and the two would contort themselves in a way that suggested spawning." In the present observations, neither the striking on the head and the contortion described by Hankinson, nor the slow, deliberate, side-by-side movements of the horned dace as described by Reighard, could be applied to these chasing activities. The time elapsed from the beginning of the movement until the parting was scarcely more than three seconds.

Spawning Associates

Spawning activities of *Notropis rubellus* in association with *Notropis cornutus chrysocephalus* were also observed. Hybrids between these two species are quite common in streams where they occur together, as noted frequently in the literature. Hubbs and Brown (1929: 36) stated that the most common American minnow hybrid is that of *Notropis rubellus* × *Notropis cornutus*. Raney (1940b: 361) pointed out that since these two species use the same type of habitat for breeding, it can generally be assumed that hybridization between them is due to chance fertilization. He observed groups of *rubellus* and *cornutus* spawning at the same time in gravel riffles and over the nests of *Hybopsis* (*Nocomis*) *micropogon*.

In the present observations, a group of *N. rubellus* chose a depression in the gravel on the outer edge of the spawning area. About two feet upstream two male *N. cornutus* maintained positions over what appeared to be spawning pits characteristic of that species. They were busily engaged in chasing intruders that came near their territory. When the group of *rubellus* moved into their chosen site to spawn, the two *cornutus* males rushed into their midst and vibrated their bodies in unison with those of *rubellus*. When the group ceased spawning and left the depression, the two male *cornutus* also returned to their former position and continued to guard their nest. This took place about ten times within an hour. After several hours of observation, eggs were obtained from the common breeding nest. They were similar in size and color to the *rubellus* eggs mentioned above.

Eggs, Hatching and Early Development

Eggs were obtained from preserved specimens of four collections. The females that showed the most distended body cavity were chosen in order to obtain the greatest amount of eggs. They were removed from the body cavity, placed in a syracuse glass and a count made with the aid of a binocular stereoscopic microscope. Three counts of 100 eggs each were made from each female. The remainder was portioned off into estimated groups of one hundred. The data (Table I) indicate that the three-year-old specimens contained the largest number of eggs, averaging 1175 per female. The two-year-old fish averaged approximately 100 eggs fewer, and the one-year-old females averaged about half as many as the three-year-old group. The one-year-old females having ripe eggs showed considerable growth on the scale beyond the annulus. Eggs secured immediately after spawning were of a reddish-orange color which disappeared as development of the embryo progressed. The eggs averaged 1.5 millimeters

Table I

Egg Counts of 28 Females of *Notropis rubellus*, Related to Age

Specimens collected in Five Mile Creek, from May 10 to June 24, 1941

Age	Specimens		Number of eggs per female	
	Number	Range of standard length, mm.	Range	Average
1 yr.	10	50–57	450–754	600
2 yr.	10	52–67	675–1460	1090
3 yr.	8	64–75	783–1482	1175

in diameter. All attempts to hatch them under laboratory conditions were without success.

On the third day of spawning, a wooden frame screened on the four sides, open on the bottom and top, and measuring 30 × 30 × 8 inches was securely placed over part of the spawning area in order to isolate it from intruders. At the same time provision was made so that sufficient water flowed over the enclosed area. Within the enclosure the mere disturbance of a stone caused eggs to rise to the surface and flow downstream, settling down again in the gravel crevices within the space of five to seven inches. Twenty to thirty eggs were gathered each day, placed in a quart fruit jar and brought back to the laboratory. The jars were placed under dripping water from a faucet. None of these eggs hatched.

On the eighth day after spawning began, no eggs were to be found in the enclosure. Upon scooping up a handful of sand and gravel at a depth of two inches, numerous small, newly hatched fry were obtained. They were all about five millimeters long, milky white, and somewhat translucent. The eyes were very large, the body tapering off quite abruptly from the head. Numerous chromatophores were distributed over the surface of the body. The caudal fin was formed, as were also the pectoral fins. The dorsal and anal fins were represented by a very thin fold along the median line of the body. Some of the fry possessed a tube-like structure along the ventral median line within the body cavity. In others the two sides of the body were closely appressed and showed no cavity. When a handful of sandy gravel containing the fry was placed in a half filled jar of water the small fry immediately wriggled vigorously to attain a position as far down as possible among the crevices of the small gravel stones. Here they ceased all movement, maintaining a vertical position, head down.

The fry were obtained on June 30, 1941. The following day an unsuccessful attempt was made to obtain fry within the enclosure. All efforts to secure them outside the enclosure also proved fruitless. On July 2, 1941, by using a fine cloth dip net, and with swift sweeps along the shallow shore of the upper pool, two of the young fry were obtained. Both of these measured 14 millimeters in standard length. They were still milky white, with an increasing amount of chromatophores spread over the dorsal area. There were three pairs of dark colored longitudinal lines, one along the lateral line, and two paralleling the mid-ventral line. The caudal, dorsal and anal fins showed strong rays, the pelvic fins showed little growth, and the pectorals were well developed. The mouth was well formed. The lobes of the brain were quite well developed and could easily be seen through the transparent skull. Four curved dotted lines indicated the gill arches. The eyes were well developed and loops of the intestine could be seen through the body wall. Fish (1932; 338–9) gave a description and line drawing of a specimen of *N. rubellus* 15 mm. long.

Maturity, Life Span and Growth Rate

The scales of 670 *Notropis rubellus* collected in Five Mile Creek were examined and the results tabulated (Fig. 1). The number of specimens for each collection and the date on which these were obtained are: May 10, 1941—104 specimens; May 15, 1941—228; June 19,

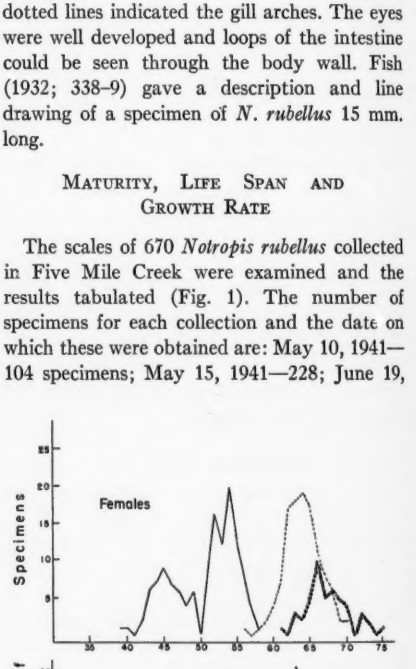

Fig. 1. Age frequency distribution of 670 specimens of *Notropis rubellus* taken in Five Mile Creek, Cattaraugus County, N. Y. The specimens were collected May 10, May 15, June 19, and June 24, 1941.

TABLE II

LENGTH AND GROWTH DATA ON 670 SPECIMENS OF *Notropis rubellus* FROM FIVE MILE CREEK

The specimens were collected on May 10, 15, and June 19, 24, 1941

Age* Sex	Number of specimens	Standard length in mm.			Percentage of total growth per year
		Range	Average	Mode	
1 yr.					
Male	145	40–61	52.0	53	76.5
Female	134	39–58	46.6	54	71.3
2 yr.					
Male	155	58–69	62.5	63	19.6
Female	127	56–70	63.7	64	21.3
3 yr.					
Male	22	61–71	64.5	65	3.7
Female	47	61–75	67.2	66	7.05

* Ages determined by scale method.

TABLE III

DATA ON 225 SPECIMENS OF *Notropis rubellus* FROM FIVE MILE CREEK IN 1940 AND 1941, EXAMINED FOR STOMACH CONTENTS

Date collected	Specimens			Stomachs with food	Stomachs empty
	Number	Standard length in mm.			
		Range	Average		
June 27, 1940	10	51–60	57	8	2
May 10, 1941	29	44–67	55.8	29	0
May 15, 1941	69	36–72	58.8	61	8
June 19, 1941	32	53–75	60.6	5	27
June 24, 1941	85	46–69	56.9	15	70
Total	225	...	...	118	107

1941—69; and June 24, 1941—269. The two collections taken in May yielded 35 specimens of undeterminable sex, and 5 such specimens were included in the collection of June 24. These forty fish are classified on Fig. 1 as "immature." By this is meant that the gonads were so undeveloped as to render identification of sex impossible. The smallest measured 30 millimeters, the largest 50 millimeters, in standard length.

Six per cent of the total collection were immature, the rest showed sufficient development of the gonads for sex determination. Of the latter, forty-two per cent were one year old; forty-two per cent were two years old; and ten per cent were three years old. In the three year age group forty-seven were females; and twenty-two males. In the one and two year age groups there were more males than females, but the difference was not of any great significance.

The rosyface shiner is one of the smaller minnows (Fig. 1). Females reach the greater length, the largest being 75 millimeters in standard length. The largest male attained a length of 71 millimeters. Both of these were in the three year age group. The length and amount of growth in the three different age groups are summarized in Table II. In the one year age group, the males attain a greater percentage of total length than the females, completing 76.5 per cent of total growth. The females in this age group complete 71.3 per cent of total growth, a difference of 5.2 per cent. In the two and three year age groups, the females average slightly more growth than the males. Briefly, males have a greater growth during the first year, females during the second and third years.

FOOD AND FEEDING

An analysis was made of the stomach contents of 118 specimens from Five Mile Creek obtained on five different dates (Table III). The specimens which contained food ranged from 41 to 72 millimeters in standard length.

Table IV gives the food items and data of 118 stomachs taken collectively, and Table V summarizes the food contents considering each of the five collections as one group. Aquatic and terrestrial insects, Arachnida, vegetation, fish eggs and fish remains comprise the diet of *Notropis rubellus*. Insects comprise 91 per cent of the total volume of food items. Vegetation was found in 8 stomachs; one contained a few strands of filamentous algae, the remaining seven contained mostly seeds of the genus *Bidens*. Fifteen of the stomachs contained fish eggs which were not identified. Plecoptera, Ephemeroptera and Diptera comprise 70 per cent of the insect food. Odonata, Trichoptera, Coleoptera and Hemiptera each total only 2 per cent by volume. Neuroptera and Hymenoptera each make up 1 per cent, and Lepidoptera, Thysanoptera, and Arachnida were in traces.

TABLE IV

STOMACH CONTENTS OF 118 SPECIMENS OF *Notropis rubellus* COLLECTED FROM FIVE MILE CREEK, FROM JUNE 27, 1940 TO JUNE 24, 1941

Of 225 stomachs examined, 118 contained food, 107 were empty. Specimens ranged in standard length from 41 to 72 mm., in age from one to three years

Food item	Stomachs containing food item		Volume content, percent	Number of oragnisms	
	Number	Percent		Total	Average per stomach
Aquatic	100	84.7	70.5	...	...
Terrestrial	56	47.4	26.2	...	...
Plecoptera	70	59.2	35.2	473	6.8
Ephemeroptera	47	39.8	16.6	160	3.4
Diptera	53	44.9	18.2	139	2.6
Odonata	5	4.2	1.9	5	1
Trichoptera	7	5.9	2.4	23	3.2
Coleoptera	10	8.4	2.4	12	1.2
Neuroptera	3	2.5	.8	5	1.6
Hymenoptera	4	3.4	1.1	5	1.2
Hemiptera	4	3.4	1.6	6	1.5
Lepidoptera	1	.8	Trace	1	1
Thysanoptera	1	.8	Trace	1	1
Arachnida	2	1.7	Trace	2	1
Insect remains*	29	24.6	10.3	...	...
Vegetation	8	6.8	2.6	...	...
Fish eggs	15	12.7	4.8	...	...
Fish remains	2	1.7	.9	...	...
Miscellaneous	2	1.7	Trace	...	...

* Not identified more specifically.

The aquatic forms of insects make up 72 per cent of the total volume, the terrestrial forms 25 per cent. This might seem to indicate that aquatic forms were preferred. However, the choice may be due to chance abundance of aquatic forms during the particular season, or in this particular stream. It does indicate that *N. rubellus* can flourish in a stream which has a sufficient supply of aquatic insects. Greeley (1927: 60) found caddis worms, mayfly nymphs, adult midges, blackfly larvae and green algae in the intestines of 3 specimens of *rubellus*. From early May until late June, the same type of food predominates. During the spawning period the consumption of food drops considerably. Two collections were made during the spawning periods, June 19 and June 24. In the June 19 collection, 27 out of 32 stomachs examined were empty. In the June 24 collection, 70 out of 85 stomachs were empty. In both collections the males and females were ripe. There appears to be no selective choice of food by either sex.

At one time rosyface shiners were seen feeding off the bottom in the deeper part of the riffle and in the pool just below the riffle. At other times they were observed feeding off the surface. In the latter case, a school of *N. rubellus* lay near the bottom of the pool just below a riffle. When food floated down on the surface of the water, the minnows rose quickly, secured the particles, and returned to their former position. On several occasions a school of about 75 *rubellus* was feeding from the surface, while another school was busily engaged in spawning. Feeding was not restricted to any particular time of the day. No observations on feeding activities were made during the night hours.

SUMMARY

Notropis rubellus was observed spawning over a period of six days from June 23 to June 28, 1941, in Five Mile Creek, Cattaraugus County, New York. Spawning was preceded by a behavior pattern in which schools of *rubellus* coursed up and down the length of two connected pools. The spawning site was located in shallow water over gravel at the side of a swiftly-flowing riffle. The discharge of eggs and sperm took place over depressions in the gravel, accompanied by violent shaking and vibration. Spawning was periodic and was accompanied by movements into and out of the breeding area. Newly-hatched young, 5 millimeters in length, were secured on the eighth day after spawning was first observed. Egg counts made from preserved specimens ranged in number from 450 in one-year-old females, to 1482 in three-year-old females. Age, determined by the scale method is limited to three years. Size according to standard length ranged from 30 millimeters in immature specimens, to 75 millimeters in three-year-old fish. Females attained the greater length. The range in size and the mean for the three age groups are: one year group, males 40–61, mean 52; females 39–58, mean 46.6. Two year group, males 58–69, mean 62.5; females 56–70, mean 63.7. Three year group, males 61–71, mean 64.5; females 61–75, mean 67.2.

TABLE V

STOMACH CONTENTS OF 118 SPECIMENS OF *Notropis rubellus* COLLECTED FROM FIVE MILE CREEK, LISTED ACCORDING TO DATE OF COLLECTION

Of 225 stomachs examined, 118 contained food, 107 were empty. Specimens ranged in standard length from 41 to 72 mm., in age from one to three years

Date:	June 27, 1940		May 10, 1941		May 15, 1941		June 19, 1941		June 24, 1941	
Number of stomachs Examined:	10		29		69		32		85	
With food:	8		29		61		5		15	
Food item	Percentage of stomachs containing food item (left column), and percentage content of food item by volume (right column)									
Aquatic	75	53.7	93.1	85.8	85.5	69.	50	40	85.7	73.5
Terrestrial	62.5	46.2	34.4	14.1	55	29.2	75	60	35.7	26.4
Plecoptera	12.5	3.7	82.7	58.3	60.3	33	20	2	40	27.3
Ephemeroptera	62.5	16.8	37.9	17.2	37.7	13.9	20	20	46.6	25.3
Diptera	75	19	37.9	10.7	50.8	22.3	...	...	33.3	22
Odonata	...	...	13.7	14.1	1.6	1.6	...	...	...	...
Trichoptera	12.5	1.8	3.4	1.	6.5	3.1	20	10	...	...
Coleoptera	12.5	Trace	6.8	11.7	11.5	3.7	...	...	...	...
Neuroptera	12.5	1.8	...	...	3.3	1.3	...	...	...	...
Hymenoptera	12.5	2.5	...	...	4.9	1.8	...	...	...	...
Hemiptera	25	12.5	...	...	3.3	1.5	...	...	...	...
Lepidoptera	...	...	...	...	1.6	Trace	...	...	...	...
Thysanoptera	...	...	...	...	1.6	Trace	...	...	...	...
Arachnida	...	...	...	...	3.3	Trace	...	...	...	...
Insect remains*	87.5	30.6	13.7	3.4	18	7.6	60	48	26.6	11.3
Vegetation	12.5	Trace	6.8	1.4	3.3	1	...	...	20	14
Fish eggs	25	7.5	...	...	21.3	8	...	...	...	...
Fish remains	12.5	1.2	...	...	...	...	20	20	...	...
Miscellaneous	12.5	1.2	...	...	...	...	...	...	...	...

* Not identified more specifically.

Food based on the analysis of 118 stomachs, consists mainly of aquatic and terrestrial insects. Arachnida, vegetation, fish eggs and fish remains were present in small quantities. Stomachs examined from breeding specimens rarely contained food.

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Fish Respiration in the Natural Oxygen Gradient of an Anaerobic Spring in Florida

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ON rare occasions one finds in nature an ecological circumstance so perfectly composed that it constitutes a natural experiment superior to any man-made construction that could be built at reasonable cost in the laboratory. Definite inferences can then be obtained with a small effort. Such natural experimental situations have additional value if they are permanent enough for data to be cumulative. In this communication some observations made in one of the remarkable Florida springs are used to draw conclusions about the respiration of fishes. It is hoped that others will be attracted to these permanent chemostatic gradients.

Beecher Springs, adjacent to the University of Florida Conservation Reserve, Welaka, Putnam County, emerges from a limestone aquifer without oxygen. As it flows downstream in its run (Fig. 1) this small stream picks up oxygen by diffusion and by photosynthesis of the algae. At a constant temperature diurnally and seasonally of 22° to 23°C., the physical and biological characteristics of this spring seem constant as surveyed 6 times over a period of 3 years. Extensive work on trace elements in another spring, Silver Springs, Marion County, indicates that a chemostatic condition is to be expected in the springs of the region. Thus Beecher Springs seems to constitute a permanent oxygen gradient in which organisms have become adjusted. White sulfur bacteria and blue-green algae dominate the boil with other algal types appearing downstream, and finally higher plants appear 300 meters from the boil. The algae have been studied by Larry A. Whitford, North Carolina State College, and will be the subject of a forthcoming paper by him. Midges (Tendipedidae and Heleidae) are found throughout the run and in part are the basis of the food chain leading to some of the fishes.

The oxygen values on the map (Fig. 1) were obtained with the Rideal-Stewart-Winkler method. Essentially similar values were recorded on June 6, 1952 and a year later on June 22, 1953. There are clearly eddies of water in the stream so that oxygen conditions at any one point fluctuate slightly with a range of about 1 ppm. Some idea of this variation from eddy to eddy can be obtained from the data in Table I. The analytical accuracy is about 0.1 ppm plus or minus.

The water is clear and the boil area smells strongly of sulfurous gases. Other properties are as follows: carbon dioxide, 10 ppm; pH, 7.2–7.7; chlorides, 166 ppm; phosphorus, 0.14 ppm; nitrate nitrogen, 0.02 ppm; alkalinity, 105 ppm ($CaCO_3$); hydrogen sulfide, 0.02 ppm.

The natural distribution of fishes in this natural gradient was observed with the aid of a face mask by swimming underwater where clear visibility is 30 meters or more. The observed species distribution is indicated in Fig. 1 and is listed below. The eddies of water permit local temporary microhabitats to acquire more oxygen so that fishes can move into the higher oxygen spots to replenish oxygen and thus can live in parts of the stream where the average oxygen may be below their physiological tolerances. Fig. 1 shows ecological tolerances under stream conditions by indicating the farthest

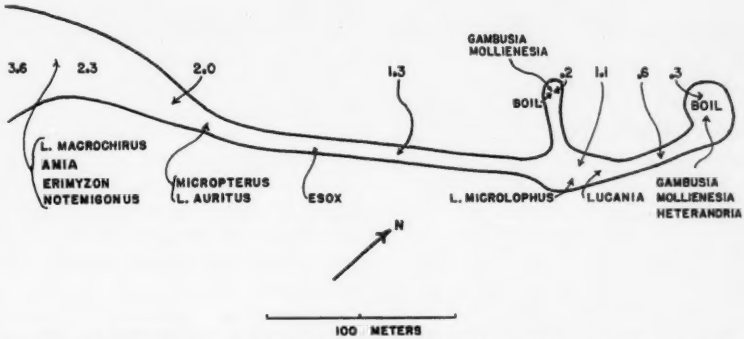

Fig. 1. Map of Beecher Springs, Welaka, Florida. Dissolved oxygen values are given in parts per million. The nearest that the fish were observed to come to the boil is indicated for 12 species in the middle of a sunny day (June 24, 1953).

point upstream that each species was observed to go. It is possible that the decrease of the small hydrogen sulfide concentration downstream is also involved. In order of distribution down the spring run the fishes represented are: eastern gambusia, *Gambusia affinis holbrooki* (Girard); sailfin molly, *Mollienesia latipinna* LeSueur; least killifish, *Heterandria formosa* Agassiz; redfin killifish, *Lucania goodei* Jordan; shellcracker, *Lepomis microlophus* (Günther); redfin pickerel, *Esox americanus* Gmelin; redbreast sunfish, *Lepomis auritus* (Linnaeus); largemouth bass, *Micropterus salmoides* (Lacépède); chubsucker, *Erimyzon succetta* (Lacépède); bluegill, *Lepomis macrochirus* Rafinesque; golden shiner, *Notemigonus crysoleucas* (Mitchill); and bowfin, *Amia calva* Linnaeus.

Experiments in Submerged Cages

Although Habs and Mueller (1948) found that the eastern gambusia lived readily in 0.3 ppm oxygen, the abundance of three cyprinodont species in the churning outflow headwaters (boil) where the oxygen is less than 0.3 ppm day and night seemed remarkable. These fishes are observed to break the surface continually. Mollys feeding on the bottom swim to the surface frequently before returning to the bottom. Although gulping by these fishes has long been observed, the writers do not know of a clear demonstration of the thresholds at which gulping is necessary for these widespread fishes. The following experiments were conducted within the springs.

Table I

Dissolved Oxygen, in Parts Per Million, in Beecher Springs, Florida

For 1953, three analyses for each station are preceded by the mean of these values. For stations, see Fig. 1

Station	VI:6:1952	VI:24:1953
Boil A	0.05	0.3 (0.27, 0.30, 0.50)
B	0.26	0.6 (0.50, 0.59, 0.65)
C	0.9	1.1 (0.40, 0.65, 2.16)
Boil D	1.3	0.2 (0.21, 0.13, 0.29)
E	1.7	1.3 (1.26, 1.31, 0.99)
F	1.1	2.0 (2.30, 1.80, 2.01)
G	...	2.3 (3.51, 1.15, 2.32)
H	3.6	...

Gambusia and *Mollienesia* taken from the boil were placed in the following situations:

1. Out of water in a dry box on land.
2. In cages in the boil at the surface so that fish could gulp at the surface.
3. In 4 cages submerged in the boil so that fishes could not get closer than 1 inch to the surface. One cage was near the surface and one was at a depth of 2 feet. A third cage included only *Gambusia* and a fourth only *Mollienesia*.
4. Submerged below the surface downstream where the oxygen was 1.3 ppm. (See Fig. 1.)

The amounts of time required for the fishes to die are summarized in Table II. Where oxygen was inadequate, distress was noticed within three minutes and most of the fishes were dead in about half the time necessary for all to succumb. Although *Gambusia* and *Mollienesia* are readily observed to pump the surface film over their gills in stagnant waters

TABLE II

FISH SURVIVAL EXPERIMENTS IN BEECHER SPRINGS, JANUARY 11, 1953

Experimental situation	Number of fishes	Duration in minutes	Oxygen tension, ppm	Percent survival
Cage in the boil at the surface of the water, fish gulping air*	37	160	0.28	92
Completely out of water*	30	22	In air	93
Cages completely submerged in boil:				
Gambusia, avg. weight: .23 gm.	27	11	0.28	0
Mollienesia, avg. weight: 0.37 gms.	27	22	0.28	0
Gambusia and *Mollienesia*:				
Below the surface 1 inch	24	19	0.28	0
Below the surface 2 feet	48	20	0.28	0
Cage completely submerged downstream*	20	25	1.3	100

* *Gambusia* and *Mollienesia*.

where oxygen is low, this is not the means of respiration in this turbulent but anaerobic stream. Definite gulping of air is observed. That gulping is necessary at these low tensions is demonstrated by the survival of those fishes with access to the surface. Since there was a rapid turbulent current cascading upward through the experimental cages an oxygenated surface film could not develop. When prevented from gulping, the fish drowned quickly. Those fishes kept out of water were quite alive at the end of 22 minutes since they demonstrated normal behavior when returned to the water.

Whereas the respiration of air by fishes has been much studied, the mechanism of aerial respiration in small cyprinodont fishes seems to have been neglected. Our dissections indicate that the Beecher Springs individuals do not differ from *Gambusia affinis holbrooki* elsewhere in having a closed swim bladder, a short intestine opening directly into a short oesophagus, and pseudobranchs (Vialli, 1926). These latter vascularized structures lining the pharynx may be the structures used as a respiratory surface for gulped air.

Another anaerobic spring in which obligate gulping by fish may be directly inferred is the large Warm Salt Spring in Sarasota County, Florida. Here, tarpon, *Tarpon atlanticus* (Valenciennes); gar, *Lepisosteus sp.*; southern variegated cyprinodon, *Cyprinodon variegatus variegatus* (Lacépède); sailfin mollys, and eastern gambusia are found in about half sea water salinity (17,800 ppm) and a temperature of 31°C. The oxygen content is between 0.00 and 0.81 ppm day and night. The tarpon were observed to roll and the smaller fishes to break the water continually. That tarpon and gars breathe with a vascularized air bladder is known from observations and dissections summarized by Babcock (1951) for the tarpon and Jones and Marshall (1953) for the gar.

These studies were aided by a contract between the Office of Naval Research, Department of the Navy, and the University of Florida, NR 163–106.

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The Opercular Bone of the Yellow Perch, *Perca flavescens*, As a Tool for Age and Growth Studies

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IT is agreed upon by fishery biologists that scales are a most useful and often the most satisfactory tool in the assessment of fish age and growth. Yet, other bony parts of fishes are known to bear year marks, and when scales are absent or for other reasons are not satisfactory for reading the age of fish, otoliths, vertebrae, dorsal spines, opercular bones, and other structures can be employed for the purpose.

In a study aimed at following the size increase of yellow perch in Lake Mendota, Wisconsin (Bardach, 1951), a secondary objective was to determine whether the opercular bone could be used in this species for calculating the sizes of fish at previous ages of their lives. These structures have been shown to bear yearly marks in *Perca fluviatilis* Linnaeus, the closely related European species; in fact, the opercle was found to be extremely well suited for growth analysis as an alternative or even in lieu of scales (Roper, 1936; Svetovidov, 1929; LeCren, 1947).

METHODS OF STUDY

The fish for this study were collected mainly by gillnets; some specimens were secured in fyke nets during tagging experiments, and a small number of fish were also supplied by anglers. Seines and metal traps were used for the capture of perch that were up to 1½ years old, since no small fish could be caught with available gillnets.

Catches with such diverse gear were considered representative of the population. The fish were weighed, measured, and sexed; and note was made of disease and parasitic infection. Scales were removed directly below the lateral line, adjoining the opercular cleft. No key scales were selected. The left opercular bone was severed from its ligaments and cut from the head. It was stored with the scales in labeled envelopes for further processing.

Scale imprints were made on thin slides of celluloid acetate by means of a jeweler's press as described by Arnold (1951). Very small scales were mounted on glass slides with clarite X, a histological mounting medium dissolved in toluene.

The opercular bones were soaked for a few hours in tepid water with some non-soapy detergent. They were lightly brushed over with a stiff tooth brush and rinsed in 85 percent ethyl alcohol. When dry after this procedure, they were ready for projection and reading.

A scale microprojector was adapted for alternate use with opercular bones by removing the condensing lens under the slide table and replacing it with the 8-inch focal length lens of a Graflex camera, suspended at the proper distance for obtaining a sharp image on the ground glass screen. This distance is quickly found by trial and error and will vary with projectors. Once the lens was mounted, the fine adjustment mechanism of the condenser lens became operative. In the machine employed, the scales were magnified sixty-five times, the opercular bones 6.16 times.

Four mounted scales of each fish were examined; the total anterior radius of each scale was traced on a strip of paper from the enlarged image on the ground glass screen of the projector. Later a mean was determined for the four measurements to investigate the relationship between body and scale length.

For translumination and projection of opercular bones a light intensity of at least 500 watts was found to be necessary. In contrast to LeCren (1947), who used the reflected image, I found it expedient to place the bone on a slide on the horizontal projector table with the light shining through it. This obviated fastening of the bone for focusing and speeded up the operation.

Opercular bones of perch show alternating regions of dark and light character (Pls. I–II). When an imaginary line is traced on the bone from its apical articulation with the head to its posterior margin, such an imaginary line will bisect the bone and cut the lighter and darker bands at right angles. Paper strips were placed on the projected image of the bone along this line and marked at the sharp transition from dark to light regions. These bands run across the

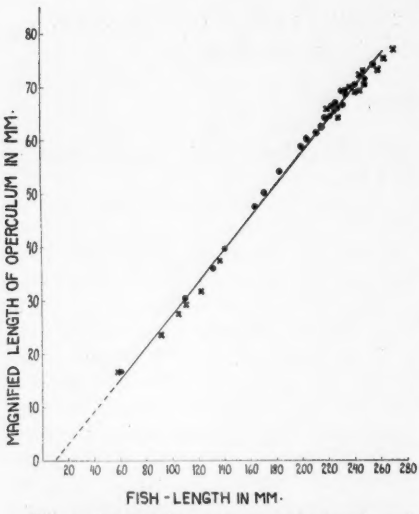


Fig. 1. Relationship between body length and length of opercular bone for Lake Mendota yellow perch over 50 mm. in length.

Each point represents 10 individual measurements. Dots indicate males; crosses, females.

main triangular plane of the bone and correspond to yearly marks. Since they can be detected in mid-winter (February to March), the lines seem to mark interrupted rather than resumed growth. They are truly annual in nature and roughly coincide with the year marks on the scales as to the time of their formation.

The time of annulus formation on the scales was also confirmed by consecutive collections throughout the year, and it was found that Lake Mendota perch showed a clear annulus after spawning in April.

The origin for measurements on the opercular bones was the center of the high ridge, at the articular apex, immediately adjoining the tip of the main triangular area of the bone (see arrow in Pl. I). This corresponds to the location used by LeCren (1947) and Svetovidov (1929), and it was assumed to be the center of growth for this bone.

Right and left bones were taken from 100 fish, and the location of corresponding annual marks were compared in the pairs. Slight deformities of one or the other bone were noted in seven fish; a severe discrepancy probably due to a previous injury had occurred on one fish of the one hundred. This was taken as sufficient proof that the healthy bone on either side might be taken for age determination. Deformed opercular were discarded; and if the irregularity was noticed at the time of measuring the fish, the normally shaped bone from the other side was kept.

Analysis and Results

The Relationship between Body Lengths and Length of the Opercular Bone—When expressed graphically, the points representing the length of a fish and the length of its opercular bone fell along a straight line (Fig. 1). This held good for all sizes over 50 mm. taken at any time of the year. The calculated correlation coefficients were 0.94 for 241 males and 0.96 for 242 females. The sizes of fish at previous stages of their life history, each corresponding to the formation of opercular marks, were calculated by first assuming that:

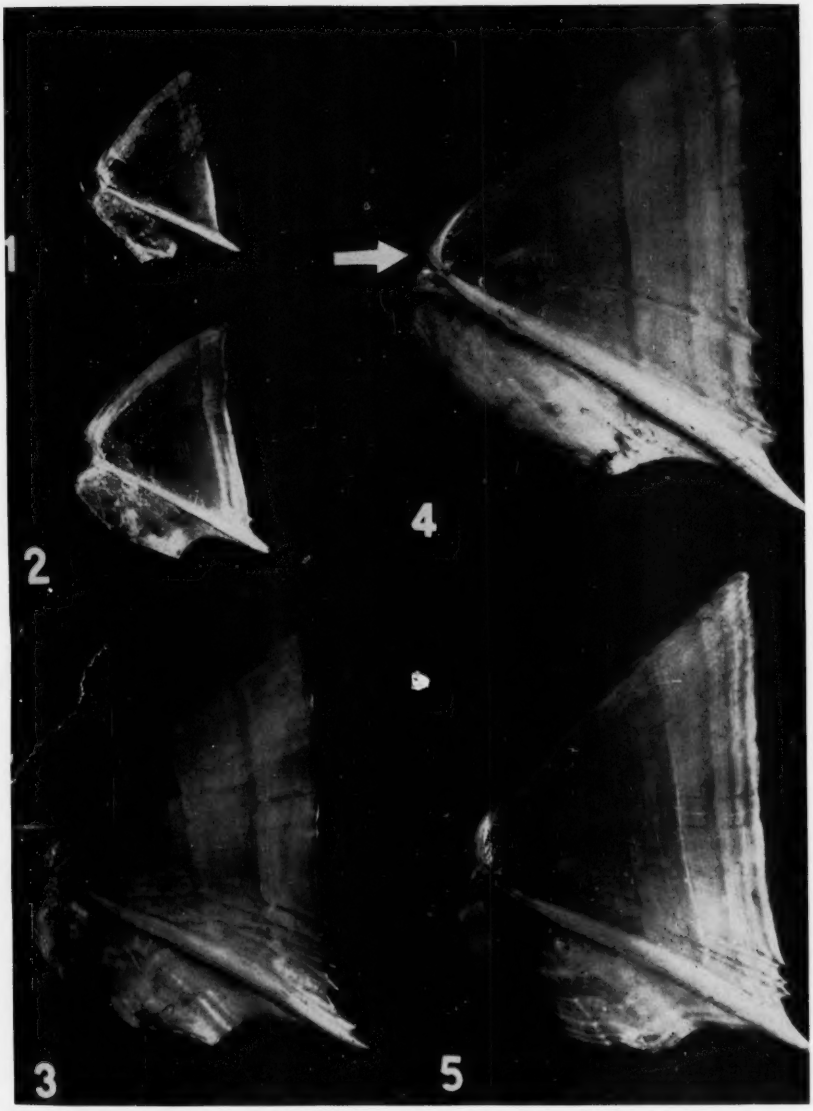
$$\frac{\text{Total length of fish}}{\text{Total length of operculum}} = \frac{\text{Fish length at operculum mark}}{\text{Length of operculum to mark}}$$

This calculation is based on a line going through the origin of the coordinates; a correction is included at the time of the calculation allowing for the size of the fish at bone formation. The bones of the head hardly appear as distinct structures in larval fish smaller than 15 to 20 mm. The intercept of 18 mm. along the X-axis (Fig. 1) then probably comes close to the size of fish from which the growth of bone and body length might be followed, if specimens were available and if a sufficiently delicate technique were worked out.

Two lines, one illustrating the empirical relationship between fish length and opercular length with an intercept of 18 mm., and the other, an imaginary line from the same points going through the origin used as a basis for the proportion, will approach each other as the values of the variables increase. The necessary correction will therefore become smaller as the fish grow larger.

Table I gives the sizes of Lake Mendota perch as they were calculated from the opercular bones. Fish from samples not employed in the bone studies were aged from their scales, and averages of the total length of the representatives of each age group were taken. These have been included in the table for comparison of calculated with measured lengths.

The Relationship between Body Length



Opercular bones from yellow perch of different ages. The arrow points to the origin of measurements for the calculation of growth. Fish 1, collected in November, less than 1 year old; Fish 2, May, 1 year old; Fish 3, October, 2½ years old; Fish 4, October, 4½ years old; Fish 5, October, 5½ years old.

Opercular bone from a yellow perch, 9 or 10 years old, collected in May.

TABLE I

AVERAGE LENGTH OF PERCH IN LAKE MENDOTA IN EARLY SPRING AT FORMATION OF ANNUAL MARK ON OPERCULUM

Fiducial limits of calculations (Snedecor, 1946, Sect. 2.12) are given in parentheses

Year	Calculated length in mm.			
	Males		Females	
	Length	Number	Length	Number
1	126 (±29)	234	124 (±27)	225
2	202 (±30)	205	205 (±26)	170
3	231 (±19)	142	239 (±20)	112
4	246 (±18)	39	248 (±25)	35
5	258 ...	6	262 ...	4
6	262 ...	2	267 ...	2

Year	Measured length in mm.			
	Males		Females	
	Length	Number	Length	Number
1	112	30	112	30
2	202	27	201	13
3	227	81	230	40
4	242	48	245	28
5	259	6	...	...
6	...	...	...	...

AND SCALE LENGTH—Similar to the procedure followed in the calculation of fish length from opercular bones, an attempt was made to plot the empirical relationship between anterior scale radius and the length of the fish. Here scale and body measurements of 165 fish were plotted. The points showed extreme scattering, and neither showed a tendency to fall along a line as was the case with the opercular bone, nor did they indicate that they might follow a simple curve which could also be used for the required corrections for deviation from a straight line through the origin of the coordinates (Segerstrale, 1933).

Similar observations pointing to a complex interdependence between body growth and the growth of the scales have been made by fishery biologists at various occasions. When a growth study of a fish population was to be made in such a case (Jobes, 1934[1]; Hile, personal communication, 1949), a different method of age analysis was used. In this instance also it would have been difficult to arrive at a correction factor equivalent to that for the opercular bones, though both the use of a key scale and a larger sample might have given better results (Segerstrale, 1933).

The fair agreement of sizes calculated from opercular bones with the measured averages (Table I) showed once more that this structure lends itself well for the assessment of fish ages and growth and that it may in some cases even be employed in preference to scales. Though further investigations along similar lines on other fish species are likely to corroborate this, it seems certain nevertheless that scales will still remain the most widely used tools for aging fish because they have many advantages that no other year-mark bearing structure can equal and because methods of aging from scales are simple and well worked out.

This report is based on material in the author's doctoral dissertation submitted to the Department of Zoology at the University of Wisconsin, entitled "Contribution to the Ecology of the Yellow Perch (*Perca flavescens* (Mitchill)) in Lake Mendota, Wisconsin." It was supported jointly by the Research Committee of the Graduate School of the University of Wisconsin from funds supplied by the Wisconsin Alumni Research Foundation and by the Wisconsin Conservation Department.

[1]Investigations of the Age and Growth of Lake Erie Perch. Unpublished manuscript.

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A New Gartersnake (*Thamnophis*) from Tamaulipas

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AMONG the numerous reptiles from southern Tamaulipas recently acquired by the University of Michigan Museum of Zoology (UMMZ) are seven examples of a new and strikingly distinct gartersnake. Three of these were included in an extensive collection made by Paul S. Martin, C. Richard Robins, and William B. Heed in 1949. Others have been secured subsequently through the continued efforts of Mr. Martin, with the cooperation of W. Francis Harrison, Rezneat Darnell, and William Z. Lidicker. In allusion to its peculiarly *Natrix*-like pattern and stocky build, features which at first sight belie the true generic relationships, this gartersnake may be known as

***Thamnophis mendax*, sp. nov.**

HOLOTYPE.—UMMZ 104044; a young male collected by William Z. Lidicker, July 28, 1951, near La Joya de Salas, Tamaulipas, ±6,000 ft.

PARATYPES.—UMMZ 101207, 101209–10, 104045, 104308, all taken along the mountain trail between Gómez Farías and La Joya de Salas, at various points between "Rancho del Cielo" and La Joya, and 108018, "Valle de la Gruta," about 1.5 miles northwest of "Rancho del Cielo."

RANGE.—Forested mountains near La Joya de Salas, Tamaulipas, from approximately 3,600 to 7,000 ft.

DIAGNOSIS.—A narrow mid-dorsal stripe bounded on either side by a single row of black-edged blotches, their lower margins usually involving the lowermost body scale row or the outer edges of the ventrals; no lateral stripes; body scales in 17–17–15 rows; a low number of ventrals and subcaudals. Differs from *T. phenax* in having a lower body scale formula, fewer ventrals and subcaudals (Table I), and in the presence of a mid-dorsal stripe; from *T. scalaris* in the absence of lateral stripes, the great lateral extent of the blotches, greater number of maxillary teeth, and in details of head pattern.

DESCRIPTION OF TYPE.—A young male; total length 368 mm., tail 85 mm. Head sharply distinct from neck. Body scales in 17–17–15 rows, reducing to 15 at a point above the 98th ventral on the left side, the 92nd on the right, by the loss of the third row. Ventrals 147, anal entire, subcaudals 68. Head shields normal, preoculars 1–1, postoculars 3–3, anterior temporals 1–1, posterior temporals 2–2, upper labials 7–7, third and fourth entering the orbit, lower labials 10–8. A narrow light mid-dorsal stripe about one scale wide extending from posterior part of parietal throughout length of body and basal third of tail, interrupted rather broadly by posterior half of nuchal blotch and narrowly at several points by black margins of lateral blotches. Lateral blotches in a single series on each side, numbering 44–45 on body anterior to vent, dark olive-brown in color, broadly outlined with black, laterally their margins involving outer edges of ventrals. Blotches covering from two and a half to four dorsal scale lengths, the interspaces about one scale length; on neck and anterior part of body blotches tending to alternate, posteriorly opposite. Upper surface of head mostly pale brown, parietals sparsely mottled with dark, forming no definite pattern. Posterior margins of internasals and prefrontals blackish, as are also the sutural margins of the more anterior upper labials. A narrow, irregular black postocular stripe involving portions of upper two postoculars, crossing center of anterior temporal, lower secondary temporal and sutural area between upper labials 6 and 7. Chin and anterior throat whitish, remainder of ventral surface dull bluish-gray.

VARIATION.—Six paratypes agree with the holotype in having the dorsal scales in 17–17–15 rows, preoculars 1–1, and postoculars 3–3. Variations in other features of scutellation are shown elsewhere (Table II). In one paratype the anal scute is divided basally, the division not extending into the distal half. With a single exception the series is remarkably uniform in pattern. In this one the dorsal blotches fade out on the third scale row. On the anterior third of the body the blotches lack the usual dark borders ventrally; posteriorly on the body

TABLE I

VARIATION IN *Thamnophis scalaris* AND ALLIED FORMS

Data on scutellation of *T. scalaris* subspp. and *T. phenax* chiefly from literature: Smith (1942), Taylor (1949), and Smith, Nixon and Smith (1950)

Characters		*mendax*	*phenax*	*s. scaliger*	*s. scalaris*	*s. godmani*
Maxillary teeth (Individual counts)		21,21,22,23	25,26	17,18	17,18	17,19
Maximum scale rows		17	19	19	19 or 17	17
	(N)	(7)	(11)	(25)	(30)	(23)
Ventrals						
Males	Mean	146.5	156.7	142.1	138.1	147.8
	Range	145–149	151–161	136–152	133–145	142–158
	(N)	(4)	(7)	(11)	(14)	(13)
Females	Mean	142.7	155.7	143	139.9	143
	Range	141–145	151–161	135–150	135–145	136–151
	(N)	(3)	(4)	(13)	(14)	(8)
Subcaudals						
Males	Mean	68.3	74.7	61.2	73.6	72.7
	Range	68–69	72–78	51–74	69–77	61–88
	(N)	(3)	(7)	(11)	(14)	(13)
Females	Mean	59.3	60	55.5	59.8	65.6
	Range	57–61	55–63	43–65	53–66	60–73
	(N)	(3)	(4)	(13)	(14)	(8)
Ventrals less caudals						
Males	Mean	78.7	82	80.9	64.6	75.2
	Range	77–80	79–85	65–99	58–70	54–88
	(N)	(3)	(7)	(11)	(14)	(13)
Females	Mean	83.3	95.7	87.5	80.1	77.4
	Range	82–84	89–106	79–97	71–87	65–84
	(N)	(3)	(4)	(13)	(14)	(8)

the borders are present but discontinuous and in the usual position, the black pigment involving parts of scales in the lowermost row and the lateral edges of the ventrals. No light lateral stripe is present, the two lower scale rows being of the same grayish shade as the spaces between the dorsal blotches. In the larger paratypes there is little contrast between the color of the blotches and of the interspaces. The paratypes differ from the holotype in having the mid-dorsal stripe complete anteriorly to the base of the parietals, dividing the nuchal blotch; in several of the series the mid-dorsal stripe involves the edges of the paravertebral rows, especially in the spaces between blotches, producing a somewhat irregular line. In all three male paratypes the head pattern is essentially like that of the type, the postocular stripe rather less well defined but following the same course, involving the sutural area between the last two supralabials; the parietals are irregularly flecked or mottled with dark pigment. The females have only a trace of this flecking and the postocular bars are absent; in two the ground color of the head is a reddish brown, appreciably brighter than that of the body. The tail-length/total-length ratio is 0.23 in each of three males, 0.20, 0.20, and 0.21 in three females.

DISCUSSION.—*Thamnophis mendax* is clearly a member of the *elegans* group as defined by Ruthven (1908: 40), but within this group its relationships are somewhat equivocal. In some respects it seems quite close to *T. scalaris*, while in others it approaches the aberrant and poorly known *T. phenax*. In its extremely reduced scutellation *T. mendax* is sharply set off both from *phenax* and from *scalaris scaliger*, the nearest geographic representative of the latter species, but resembles *scalaris godmani*, geographically the most distant of the subspecies. This resemblance is probably to be

TABLE II

VARIATION IN *Thamnophis mendax*

Catalog number	Sex	Upper labials	Lower labials	Ventrals	Caudals	Ventral at row reduction	Maxillary teeth	Total length	Tail length	Body blotches
104044	♂	7–7	10–8	147	68	98–92	..	368	85	45
101209	♂	7–7	8–9	145	(56+)	83–76	21	(424)	(87)	46
104308	♂	7–7	8–9	149	69	91–87	..	455	105	53
108018	♂	7–7	10–10	145	68	84–86	..	493	114	47
101207	♀	8–8	10–10	141	57	98–100	23	525	110	37
101210	♀	7–7	9–9	142	60	91–93	21	595	122	43
104045	♀	6–7	9–9	145	61	87–86	22	710	145	52

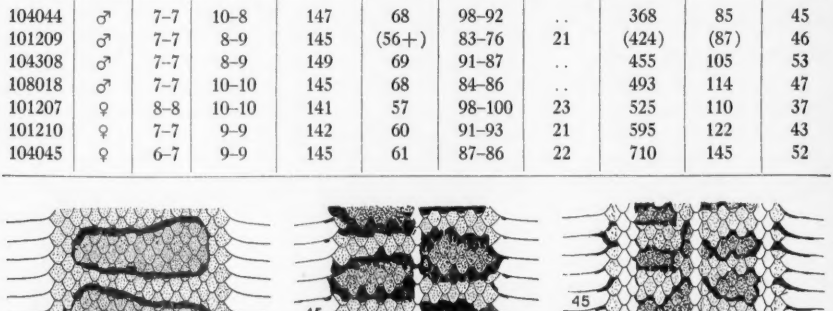

Fig. 1. Dorsal pattern on anterior portion of body in *Thamnophis mendax* and related forms. *T. phenax*, UMMZ 89363, Potrero Viejo, Veracruz; *T. mendax*, UMMZ 104044, La Joya de Salas, Tamaulipas; *T. scalaris scaliger*, UMMZ 99760, 26 km. south of Patzcuaro, Michoacan. Position of 45th ventral indicated in each figure.

regarded as a parallelism, since *mendax* and *s. godmani* otherwise have little in common.

In features other than scutellation, however, *mendax* might be considered a link between *scalaris* and *phenax*. The number of maxillary teeth is intermediate. Most of the peculiarities of pattern which distinguish *mendax* from *scalaris* and its subspecies are either duplicated or closely approached in *phenax*. These include the absence of a lateral stripe, the large size and quadrangular shape of the lateral blotches, the absence of more than a single row of these blotches, and the intervention of a light area between the postocular bar (when present) and the dark markings of the parietals. On the other hand the constant presence of a complete mid-dorsal stripe in *mendax* suggests relationship with *scalaris* rather than with *phenax*. Many individuals of *scalaris scaliger*, moreover, have only a single row of blotches on each side, at least on the anterior part of the body, a condition which might be considered an approach to the pattern of *mendax* (Fig. 1). The extreme lateral extent of the dorsal blotches is a feature peculiar to *mendax*.

Conceivably all of these gartersnakes will eventually prove to be conspecific. The evidence of distribution, however, affords some definite, although rather meager, evidence against this hypothesis. *Mendax*, which seems intermediate between *phenax* and *scalaris* in some respects, occupies a peripheral rather than a central geographic position, in our present knowledge quite isolated from the others. Furthermore, both *phenax* and *scalaris scalaris* are known from the region of Orizaba (Smith, 1942), while *phenax* and *scalaris scaliger* are reported to occur together on Cerro Conejo in San Luis Potosí (Taylor, 1949). In addition to this evidence of sympatry, it should be noted that the differences between *phenax* and *mendax*, and between either of these forms and *scalaris*, are of a distinctly greater magnitude than those between the

races of *scalaris*. On the whole it seems preferable to treat both *phenax* and *mendax* as full species; the relationship of *mendax* to *scalaris*, however, seems close, and in view of the scanty material now available such a treatment can only be provisional.

The largest of the seven known examples of *mendax* is 710 mm. in total length, a notable size for a *Thamnophis* with so low a body scale formula, suggesting that *mendax* may prove to be a distinctly larger snake than *scalaris*.

All of the known examples of *mendax* have been taken in forested country, the majority in oak-pine forest, two in the denser and more humid oak-sweet gum forest at lower elevations in the same mountains. Surface water, either in the form of ponds or streams, is quite infrequent in these limestone mountains, and it seems probable that *mendax* is essentially a forest snake, more independent of water than many Mexican *Thamnophis*. The stomachs of two of the specimens contained remains of salamanders of the genus *Pseudoeurycea*.

ACKNOWLEDGEMENTS.—I am indebted to Paul S. Martin for the privilege of studying and describing this snake, and to George H. Lowery for the loan of specimens of *Thamnophis phenax* from the collection of the Louisiana State Museum.

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Further Observations on the Desert Tortoise, *Gopherus agassizi*, of California

LOYE MILLER

AT the time that I published the results of several years' observations on the desert tortoise, *Gopherus agassizi*, in southern California (Miller, 1932), there were available only very limited records of specimens of known age and there were many questions which were necessarily left unanswered. Some of them still remain unanswered; on the other hand, certain quite dependable data have accumulated. Individuals have been under observation for as long as 20 years in captivity under more or less natural conditions in outdoor runs at Los Angeles. Others of uncertain age have been observed for a similar period, and some additional data from interested laymen have been obtained. Assistance of these observers is here gratefully acknowledged.

VARIABILITY OF THE YOUNG.—Measurements were made on 11 hatchlings that were taken in California deserts at a stage when the umbilical tissue still showed as a shriveled remnant (Table I). Carapace length was taken from the notch in the nuchal scute to that in the caudal. Width was measured at the point of greatest diameter, which was most often slightly posterior to the half-way point in length of carapace. The same is true of the depth. These measurements were taken on individuals that were captured before any growth had taken place. A slight increase of certain diameters had doubtless occurred as the animals were released from the confining eggshell, but true growth was not indicated on any of the shields (Fig. 1).

Some of the hatchlings were weighed, but the retention or the voiding of relatively large quantities of water makes weight an extremely uncertain index of progress in growth, hence

Fig. 1. Drawings of details of newly hatched tortoise No. 11 from Mojave Desert, California. a—residue of umbilical tissue; b—nuchal scute; c—third vertebral scute; d—caudal scute. Twice actual size.

TABLE I

MEASUREMENTS (IN MM.) OF INFANT TORTOISES THAT STILL SHOWED SHREDS OF UMBILICAL TISSUE

Specimen Number	Length	Width	Depth
2	53.0	39.0	20.4
3	50.0	44.0	24.4
4	39.9	37.5	21.2
6	44.7	40.5	22.3
7	43.7	39.8	23.0
11	46.9	40.6	21.7
12	46.8	42.8	24.3
13	47.2	41.0	23.8
17	44.2	41.2	22.8
19	47.9	38.5	23.3
20	45.2	40.3	22.5
Average.....	46.3	40.4	22.5

this factor was disregarded. Variation in size at hatching is surprisingly small.

Variation in the color of California young was discussed in my former paper (1932) and subsequent observations add nothing except to accent the variability. I was fortunate, however, in obtaining three young animals from Hermosillo, Sonora. Two were in the hatchling stage and the other, to hazard a guess based on size, was probably in its fifth year. All three were very much darker in color than the California animals (Plate I). The pale yellow of the California hatchlings was replaced by ochre or even burnt orange. The dorsal color in one of them (No. 20) was almost entirely slate black, with a few spots of burnt orange. This individual survived for 7 years, by which time it had become almost entirely slatey black, relieved on the plastron with some rich mahogany. The soft parts were very dark and the iris was straw color. At 7 years some scutes had seven rings, others as many as 11. The scutes were very deeply marked, making for a rough shell. The other infant did not survive but the 5-year-old, which was left in my charge, was much the same color as was No. 20 at 7 years of age. The dark soft parts were spotted with rich yellow, and the shell was rendered very rugose by a marked elevation of the central part of each scute that left the margins thereof depressed.

Furthermore, all the Mexican individuals displayed a characteristic outline when viewed from directly above. The lateral margins were almost rectilinear and parallel along most of the body, rounding off fore and aft in nearly equal curves. In the California animals observed, the two lateral marginals diverge slightly toward the rear so that the widest point in the carapace is nearest the pelvic limbs and the posterior contour has a slightly greater radius of curvature than does the anterior.

Considerable abnormality in scale pattern was displayed by a hatchling from the yard of Mrs. Bernice Laws Nelson of Covina, California (see also Grant, 1946). The nuchal scute was almost crowded back from the margin by the marginals and was asymmetric. Vertebral scute No. 1 was divided by an oblique line from anterior to posterior, trending to the left. Scutes 2, 3, and 4 were rendered asymmetric by the fact that there were only three costals on the right side instead of four. The caudal was divided on the median line into a symmetrical pair. Other scutes appeared normal. At the age of 11 years the cleft in vertebral No. 1 was still marked. The parent had been

in solitary captivity for 1½ years prior to this animal's hatching.

EGG LAYING IN CAPTIVITY.—I was never fortunate enough to observe normal egg laying among my tortoises. Perhaps the University of California campus at Los Angeles where they were kept was located too near the sea coast (5 miles) and climatic conditions were unfavorable. Layings and hatchings were, however, reported to me from San Fernando, Pasadena, Covina, Monrovia, and San Bernardino, California, and from Sante Fe, New Mexico, all areas of lower humidity and greater temperature extremes than Los Angeles. Reports from various of these sources enable me to state certain facts.

Description of the egg-laying process is here quoted from a note by Mrs. Barbara Monroe of San Bernardino (other reports support most of the statements):

> Last summer Tom was very restless for several days, trying to get out of her pen—early one afternoon she chose a spot where there was dirt and started to dig. From the time she started until the eggs were laid and covered, she did not move from her original position. All the digging was done with the hind legs—first with one, resting her weight on the opposite leg, then reversing the process in a rhythmic, measured pattern. She dug a round hole straight down about three inches across and seven inches deep, then slanted a fan-shaped compartment forward. This digging took well over an hour; then she rested a short while and then started laying.
>
> As each egg dropped down into the hole it rolled forward; she reached in carefully with one hind foot and moved it aside. She laid eight eggs over a period of perhaps an hour. Frequently during the laying she hissed. She seemed entirely unaware of us who were watching. When the eggs were laid she started covering them, still without change of position and still with the hind legs. When the hole was completely covered, she packed it firmly with her feet and shell, discharged at least a cup of water and continued packing the wet dirt till it was very smooth and hard. When she was satisfied she crawled away, paying no more attention to the nest.

About six weeks later a second clutch was laid by the same female but the person observing did not count the number laid.

Mrs. Monroe observed another laying by this animal the following summer. This laying was photographed by Mr. Monroe (Plate I). The same restlessness and refusal of food suggested that egg-laying was at hand, so the animal's weight, 16½ lbs., was recorded. Immediately after the laying of 14 eggs, she weighed 14½ lbs.

Procedure in this case was exactly the same as that observed the previous summer, although the nest hole was less symmetrical because of its location against a wall. Some days after egg laying she had access to water and drank copiously, although previous to oviposition she had shown no interest in water.

Other observers have reported to me in less detail. The digging procedure is the same, and their accounts differ only in the omission of some details. The number of eggs deposited in one nest varies from two to fourteen (2, 3, 5, 5, 8, 10, 14). Two different observers mentioned the fact that the parent reaches down with the hind foot and places the egg after its deposition. The excavation is all accomplished with the hind foot whereas, in burrowing, only the front feet are used. Details are not given as to how a vertical walled hole only 3 to 4 inches across can be dug to a depth of 7 inches. Perhaps the loosened earth is lifted out on the upper surface of the elephant-like hind foot.

SEASON AND INCUBATION PERIOD.—All records of oviposition from southern California (8 nests) and New Mexico (1 nest), where conditions were favorable, give the dates as late spring to summer, the majority being in July. Unfortunately the eggs laid by Mrs. Monroe's tortoise as above recorded did not hatch. Others who observed hatching had not observed the deposition of those same eggs. The only normal hatchings recorded (3 nests) were in October.

Mr. S. W. Evans of Santa Fe tried to hatch ten eggs by artificial incubation. He reported results as follows: eggs laid on July 25, 1949; first egg hatched on Oct. 17 (85 days); second hatched on Oct. 21 (89 days). Other eggs had not hatched by February 24, 1950, but "some have embryos." He postulated a sort of "hibernation within the egg." Incubation of one egg at San Diego, California, was recorded by Nichols (1953) as 103 days.

Eggs laid in Pasadena in July, 1949, were hatched in October, except one which hatched on December 6, 1949. The infant tortoises from Hermosillo, presented by Mrs. Lily Davis, were reported as hatched in June, 1941 (oviposition date not reported).

In summary it may be concluded that eggs are commonly laid in late spring or in summer and are hatched the same year in the fall or

TABLE II

GROWTH RECORD OF *Gopherus agassizi*, SPECIMEN NO. 6

Whole numbers are measurements to the nearest mm.; all records were made in October of the years indicated

Year	Length	Width	Depth
1928	44.7	40.5	22.3
1929	46.8	43.4	23.2
1930	56.3	49.1	27.3
1931	72.3	58.5	34.3
1933	83.4	68.8	37.4
1934	87.3	71.5	38.3
1936	115	84.7	44
1938	123	98	50
1939	138	109	58
1940	150	218	60
1941	164	128	68
1942	174	134	73
1943	187	142	77
1946	205	163	93
1948	232	180	102

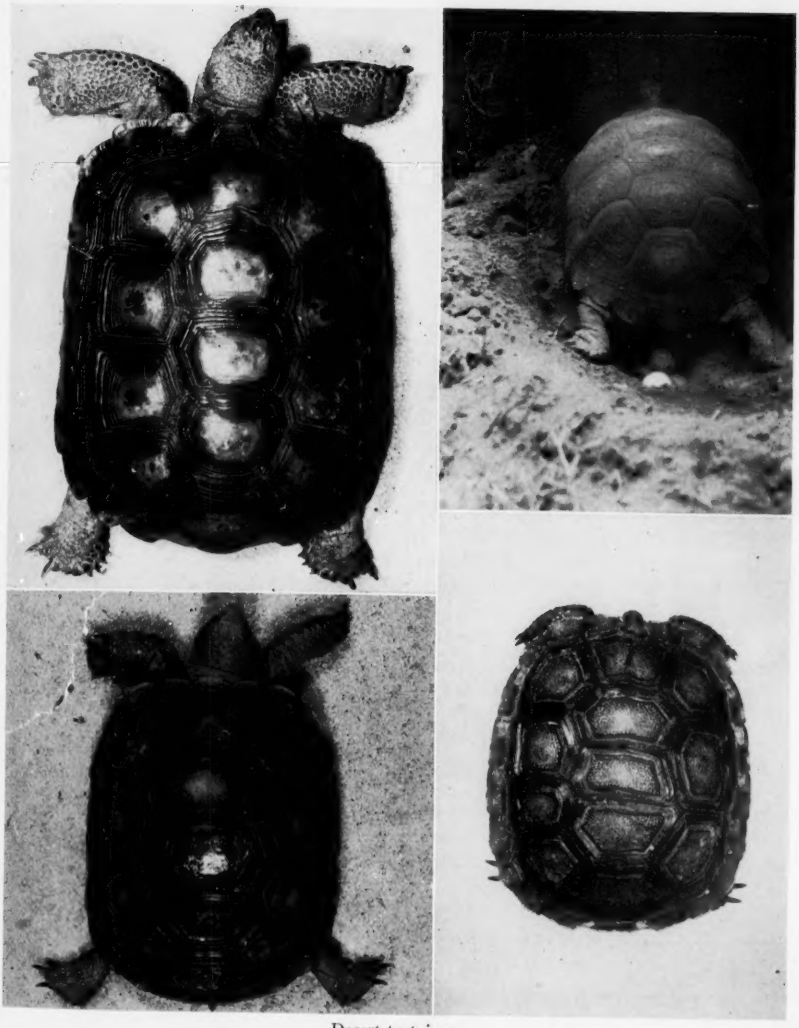
winter. The incubation period of eggs in the same clutch may vary greatly. Eggs are deposited in fairly rapid succession.

DEVELOPMENT OF YOUNG.—Rearing of these reptiles in captivity is attended with a measure of uncertainty. Two hatchlings from the same locality and date, probably even from the same clutch, have responded in opposite fashions to animal-house care at Los Angeles. One grew rapidly and the other not at all. Food was abundant, varied, and seemingly to their liking. Water was always available. Temperatures of summer and of winter were less extreme than on the desert, but the tortoise at home becomes inactive during extremes of either heat or cold. Air and soil humidity are both greater at the Los Angeles campus than at sites farther inland; also there may be a shortage of ultra-violet light, although the popular sun-tan of our beach habitués has to be acquired with some care. The mortality among my juvenile specimens is possibly higher than it would be in the wild, were the factor of "enemies" removed.

Growth rates given in my 1932 paper were limited to a period of 3 years of observation on ten individuals, only four of which were hatchlings. Two of these died quite soon after that date but three hatchlings have been under observation for 18 to 20 years. Curves of their progress in carapace length show remarkably uniform gradients. No. 6 (Plate I) was kept for 20 years during which time his carapace length increased from 44.7 mm. to 232 mm. The plastron at 5 years was still slightly soft at the center. At 11 years it was entirely rigid. At 16 years the concavity of the plastron in the pelvic area was beginning to develop, and at 20 years the rostral horn was fully extended and curved upward. My notes describe him as "a big, lusty buck at 20 years." (Table II and Fig. 2). No. 11 was captured two years later than No. 6. Her shell was hard at 6 years, and since no secondary sex character had developed at 17 years, she was considered as probably female. No. 13 had hardened the plastron at 7 years and was considered a female since no secondary sex character had developed at 17 years. Two small animals picked up at the probable ages of 6 and 7 years had no secondary sex characters developed at the age of 25 years. Their shells were hard at the time of capture. No. 15 was brought in from the desert as a youngster of 13 years, as estimated by length of the carapace (165 mm.). When placed with other tortoises, it immediately stimulated courting activity in a large male. No response on her part was evident.

It would appear probable from my limited evidence that the shell becomes completely hardened as early as 5 years or as late as 11 years and that external secondary sex characters of the male begin to develop at 16 to 17 years and are complete by 20 years. The female may attract males at 11 to 12 years of age.

Identification numbers were at first applied in India ink and covered with lacquer. This plan was found unsatisfactory and several others were tried. The final method was to carve the number in the corneous layer of the caudal plate and fill the glyphs with pigment, then cover with lacquer. If the cut is made too deep, the proliferation layer is stimulated to produce new corneum and the number is distorted. Abrasion is reduced to a minimum by placing the mark well down over the convexity of the carapace. Even then, frequent check and renewal of markings were necessary. For large specimens we attached a rear "license plate," a number stamped on sheet brass and attached with brass wire to the lower edge of the caudal scute and to one side of the median line. Even these markers were sometimes lost



Desert tortoises

Lower left: Infant tortoise (No. 20) from Hermosillo, Sonora.
Lower right: Tortoise at the age of 24 months; hatched at Covina, California. Scutellation abnormal.
Upper left: Tortoise (No. 6) at the age of 14 years. Taken as a hatchling in Mojave Desert. Note smoothness of central part of scutes.
Upper right: Female laying eggs at San Bernardino, California, in July, 1945.

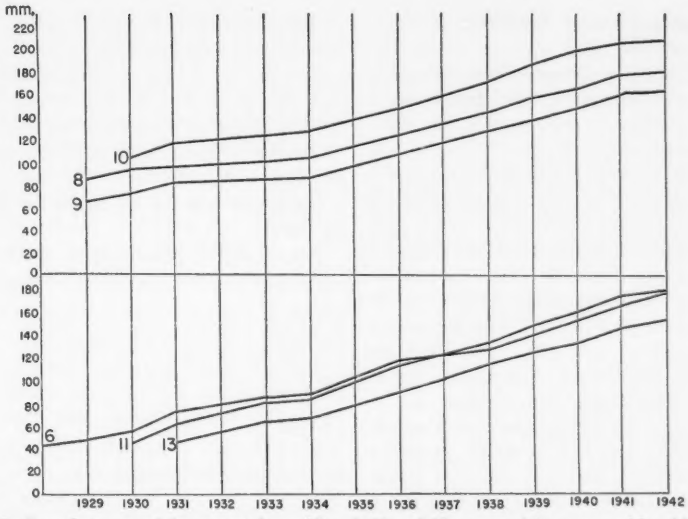


Fig. 2. Growth curves of desert tortoises. Nos. 6, 11 and 13 measured from year of hatching; Nos. 8 9 and 10 were estimated to be 5 to 8 years old when first measured.

as the animals climbed over each other in the pens.

C. M. Bogert employed the brass tag method with a measure of success in tagging animals on the desert at Lovejoy Spring. One of Bogert's experimental animals was picked up and brought to me by a person uninformed of the experiments. The brass tag was still in place after 27 months. The animal was found at the same locality where it was tagged, and it was returned there after its visit to the metropolis.

The oft-repeated popular tales of chelonians that have survived in the wild for a century or so, as evidenced by initials and dates carved upon their shells by historical pioneer personages, held a great fascination for me as a boy. My experience with regeneration of injuries and the obliteration of identification marks in the desert tortoise have greatly cooled my enthusiasm for such tales (Miller, 1932).

Calculi.—In my 1932 paper suggestion was made that calculi within the urinary bladder might be a cause of death under natural conditions. Four cases of death of mature animals were ascribed to this cause. In the laboratory, however, it was learned that these calculi may form in quite young animals and that they are on occasion voided by seemingly healthy individuals. Unfortunately at the time this observation was made there were five youngsters in the carrying cage brought to my office from the vivarium. One had been in captivity for 12 years (No. 6) and two of them of about the same size (163 mm.) had come in from the desert at the estimated age of 5 to 7 years. A calculus was discovered in the cage after 48 hours of confinement of the young animals. It was globoid, with diameters ranging from 17 mm. to 18 mm., and had all the characters ascribed to the larger stones mentioned in 1932. Evidently these stones are not of necessity fatal and may be of more common occurrence than suspected. I am now inclined toward the belief that the very capacious urinary bladder is ordinarily not greatly crowded by calculi and that they may not strongly influence the animal's health. Possibly they may be of more or less normal occurrence on the desert where free drinking water is seldom available. It is regrettable that I cannot say which of my young animals voided the stone, since water and fresh green food were always available in the animal yards.

Synoptical Statement

Hatchlings have been collected and kept in animal pens at Los Angeles until 20 years of age.

Growth rate as plotted (Fig. 2) from cara-

pace lengths produced remarkably uniform, rectilinear curves.

External male characters began to appear indistinctly at 16 years, were definite at 17 years, and complete at 20 years in my specimens of known age.

A female from the desert, of 165 mm. carapace length (=10 to 11 years), stimulated courting activity in a large male.

The "egg tooth" is not evident after the second year.

The plastron may remain flexible at the center from 5 to 10 years, with animals in captivity.

Marginal notches in nuchal and caudal scutes become closed at 10 to 13 years.

No satisfactory correlation between season and formation of "growth rings" on scutes could be observed.

Two hatchlings from Sonora were kept in a constant temperature laboratory at 85° F. By the second year they had produced 4 to 5 "growth rings."

Three Mexican animals were all very dark colored and at 7 years are almost slate black with mahogany spots. The carapace is very "knobby."

No eggs have as yet been produced by my captive specimens, but data concerning egg laying have been obtained from adults brought in from the desert.

Fertile eggs have been laid 1½ years after possible contact with a male.

The number of eggs recorded has been 3, 5, 5, 8, 10, and 14. Two clutches were laid by one female, with an interval of 6 weeks.

Egg laying took place from late May to July, but most often in July.

Egg-laying behavior is described and photographed.

The incubation period was 83 to 89 days at Santa Fe, New Mexico, and 103 days at San Diego. The usual hatching season is October but there is one record for December.

Numbers carved on the carapace tend to disappear in 2 to 3 years. Such marks are not dependable unless checked each year. Brass tags wired to the carapace may be torn off, but one specimen had carried such a tag for 27 months.

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A New Species of Frog of the Genus *Eleutherodactylus* from Guatemala

Carlos B. Bumzahem

In the herpetological collections of the Chicago Natural History Museum are seven specimens of the genus *Eleutherodactylus* which appear to represent a heretofore undescribed species. They were collected on Volcan Tajumulco, near San Marcos, Guatemala, on February 15 and 27, 1934. These are the first representatives of the genus to be described from the southwestern highlands of the Guatemalan Plateau, as Stuart (1951) had found no record of the genus up to that time. I have the honor of naming this species for Colonel Clifford C. Gregg, Director of the Chicago Natural History Museum, in recognition of his many kindnesses to me.

***Eleutherodactylus greggi*, sp. nov.**

Holotype.—Chicago Natural History Museum (CNHM) No. 20876, an adult female, collected on Volcan Tajumulco, near San Marcos, Guatemala, on February 15, 1934, by Dr. Karl P. Schmidt.

Paratypes.—Six, CNHM 20658, 71838–71842, also collected on Volcan Tajumulco by

Dr. Schmidt. Three, CNHM 20658, 71841–2, were collected under stones at an altitude of 6,000 feet. Three are males and three are females.

DIAGNOSIS.—An *Eleutherodactylus* lacking both inner tarsal fold and inner tarsal tubercle; row of outer tarsal tubercles present but not prominent; heel reaching 3 or 4 mm. beyond tip of snout; a pair of dorsolateral ridges from corner of eye converging somewhat on rump, enclosing a uniform light-colored area; inguinal gland present.

DESCRIPTION OF HOLOTYPE.—Vomerine teeth, two prominent, oval elevations, slightly posterior to the choanae; length of snout slightly longer than horizontal diameter of eye; loreal region angular; tympanum one-half horizontal diameter of eye; a fold from posterior edge of eye curving toward insertion of forelimb; two dorsolateral ridges from posterior corner of eye converging somewhat on rump; no other ridges or protuberances of any sort between dorsolateral ridges; sides slightly tuberculate; inguinal gland present; belly smooth; heels overlapping; upper surface of legs and posterior surface of thighs slightly pustulate; heel extending beyond snout; a large inner and small outer metatarsal tubercle; rows of outer tubercles present but very inconspicuous; toes slightly webbed.

Color (in alcohol) between dorsolateral ridges and on upper surface of snout light brown; sides more darkly pigmented along dorsolateral ridges, in contrast to lighter dorsum and lighter sides below level of tympanum; upper surfaces of limbs more darkly pigmented; labium, loreal region, and especially area around tip of snout darkly pigmented; a light line from tip of snout to lower edge of labium; under and posterior surfaces of thighs light.

Snout–vent measurement 36 mm.; head measured to posterior corner of eye 12 mm.; eye diameter 5.5 mm.; leg to heel 40 mm.; heel to tip of toe IV 33 mm.; arm to wrist 13 mm.

VARIATION.—The paratypes agree essentially with the holotype except in degree of pigmentation, presence of a dark smudge between the eyes (all except CNHM 71839–40 which agree with the holotype), and size of the tympanum. The three males (CNHM 71840–2) have a tympanum width equal to two-thirds the horizontal diameter of the eye. Three specimens (CNHM 71838, 71840–1) show a greater contrast between the band of pigment along the dorsolateral ridges and the light dorsal area enclosed therein. Two individuals (CNHM 71839, 20658) are generally darker and one (CNHM 71842) is generally lighter. Three specimens show banding on the upper surfaces of the hind limbs, while all paratypes show a slight trace of banding on the forelimbs.

REMARKS.—*Eleutherodactylus greggi* seems to agree most closely with the members of the *E. mexicanus* group (Taylor, 1941) all of which lack an inner tarsal fold or tubercle and possess an inguinal gland. It differs from *occidentalis* in having the first finger shorter than the second, from *calcitrans* by having heels which overlap, from *mexicanus* by having longer legs, and from *saltator* in possessing distinct dorsal ridges. It differs from all in coloration and dorsal ridge pattern.

Two Guatemalan forms, *E. anzuetoi* and *E. xucanebi* also lack inner tarsal folds and tubercles, but neither possesses an inguinal gland or has the heel extending beyond the snout.

Eleutherodactylus greggi has a remarkable superficial resemblance to *dorsoconcolor*, a member of the *rhodopis* group, but may be easily differentiated from all members of that group by its lack of an inner tarsal fold or tubercle.

Three specimens in the collections of the University of Illinois Museum of Natural History (UIMNH) appear to be referable to this species. They are UIMNH 34232–4, collected in the Región de Soconusco, Chiapas, México, between 1944 and 1949 by Eizi Matuda. I do not include them in the paratype series due to their somewhat desiccated condition.

I wish to thank Drs. Hobart M. Smith and Donald F. Hoffmeister for their very helpful advice and critical examination of the manuscript.

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The Ingestive, Digestive and Respiratory Systems of the Microhylid Tadpole, *Hypopachus aguae*

R. Maxwell Savage

In a previous paper (Savage, 1952) it was shown that the tadpoles of several species of microhylid frogs have become highly specialized for feeding on very small particles. By the courtesy of Dr. L. C. Stuart some specimens of a Guatemalan species, *Hypopachus aguae* Stuart, were made available for examination, and it is now possible to give a more complete account of the anatomy of a microhylid tadpole than has been possible before.

Methods

The animals had been preserved in 10 per cent formalin and were in excellent condition. The tissues of tadpoles fixed in this way are, however, excessively transparent, and dissection is made easier by staining. Dilute borax carmine has been used by Sedra (1950) and was tried, but it was found preferable to place the specimen in Bouin's fluid for 24 hours. The tissues are then opaque yellow, and fine structure is easy to see. For sections, Masson's and Heidenhain's Azan stains were chiefly employed. All the tadpoles were fully developed, but not metamorphosing.

Description

The structures are described in the order in which the stream of entering water reaches them.

Lips.—As in other microhylids, the lips are in the form of flaps, produced in this species into finger-like processes. There are no teeth.

Mouth.—The mouth is bounded posteriorly by a ridge marking the limits of the pharynx. As in other microhylids, the nares do not open to the exterior. The lips and the mouth are so formed that the entering stream of water is directed into the nasal cavities, a pair of tubes ending blindly behind. The entrance to these tubes is fringed with compound papillae, which are curved about their axes, the shape being like that of a hand when the thumb is brought over the palm. Besides their probable sensory function, these papillae evidently also play a part in directing the stream of water. They are not ciliated, but are covered with squamous epithelium.

There is a tongue in the floor of the mouth. Whether this is functional in the tadpole is doubtful. A tadpole must not only have organs for its own specialized life, but is also a larval stage in which adult structures of no present value are being laid down. The tongue may be one of these.

The nasal cavities are lined with ciliated epithelium, with goblet cells. The remainder of the epithelium of the mouth is not ciliated.

There is a large central papilla at the extreme anterior end of the dorsal part of the oral cavity, just where the entering stream of water would impinge, and the boundary between mouth and pharynx is marked ventrally by a row of simple papillae, flanked by two compound papillae (Fig. 2).

Pharynx.—The glottis, as in other microhylids that have been examined, lies freely exposed, filling a gap in the ventral velum, and does not lie under it as in *Rana* and *Bufo* (Fig. 2). It resembles that of the other microhylids, and opens into a trachea which runs into the septum between the two 4th gill arches. At about the level of the opening of the oesophagus, the trachea divides into bronchi, leading to thin-walled lungs, placed in the extreme dorsal part of the body cavity (Fig. 2).

The ventral velum is of the usual microhylid pattern, projecting well over the gills. It is not free as in *Rana* and *Bufo* but is adherent to the arches. If it is followed round at the lateral extremities, it becomes the dorsal velum, which as in other tadpoles does not extend quite so far as the lateral wall of the pharynx, and thus leaves a space through which material can pass to the region posterior to the dorsal velum.

Oesophagus.—This is unique among tadpoles hitherto described, and unusual in any animal. A longitudinal septum arises from the dorsal wall and extends nearly to the ventral wall (Fig. 3). It is a continuation of the right and left dorsal vela, which thus appear to plunge down into the oesophagus (Fig. 1). The

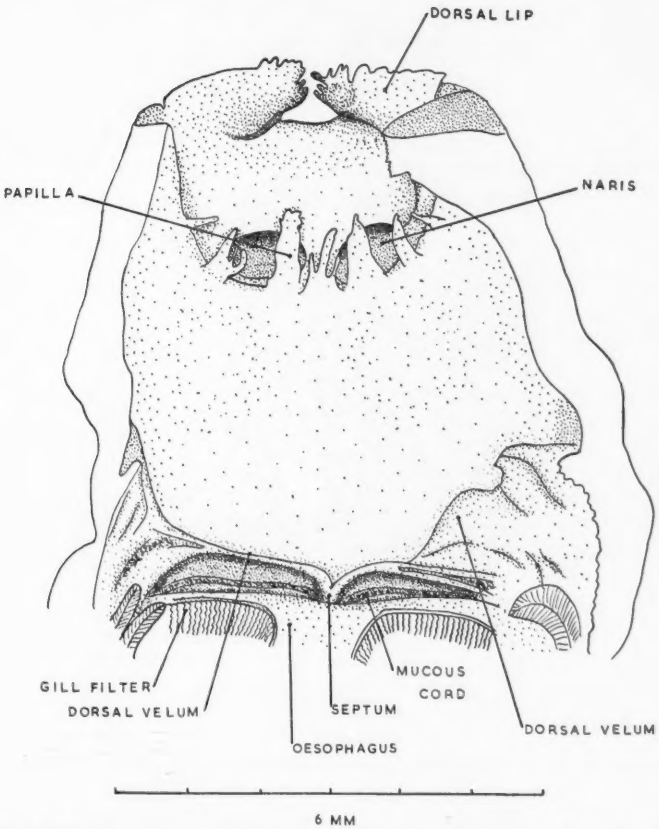

Fig. 1. View of the roof of the mouth and pharynx showing the mucus cords, with the dorsal velar folds becoming the oesophageal septum.

mucous cords form as usual in the space behind the dorsal velum and each has thus its own duct in the oesophagus. The available space in the oesophagus, already small in diameter compared with that of *Rana*, is reduced to little more than that of the diameter of the cord itself, and it appears that in this species specialization in microphagous feeding has proceeded to the extreme limit, for it would be almost impossible for particles to be thrown directly into the oesophagus. Probably all the food is collected in the mucous cords.

The septum diminishes in size posteriorly, and disappears at about the point where the mucosa of the oesophagus becomes folded into longitudinal ridges. In *Rana* and *Bufo*, both with an undivided oesophagus, the mucous cords twine about each other. It is not easy to see the advantage of the arrangement in *H. aguae*, in which a structure is developed by which twining is prevented, but presumably there is some gain in efficiency. Perhaps the larger relative area available for the development of cilia is one advantage, for the septum is ciliated, as is the remainder of the oesophagus (Fig. 3). The rest of the foregut is ciliated, but not completely, the cilia being found mainly on the outside of the bends, as Barrington (1946) showed in *Rana* and *Bufo*.

MANICOTTO.—This term, used by Lambertini (1929) and adopted by Barrington (1946) as an alternative to "larval stomach," is preferred

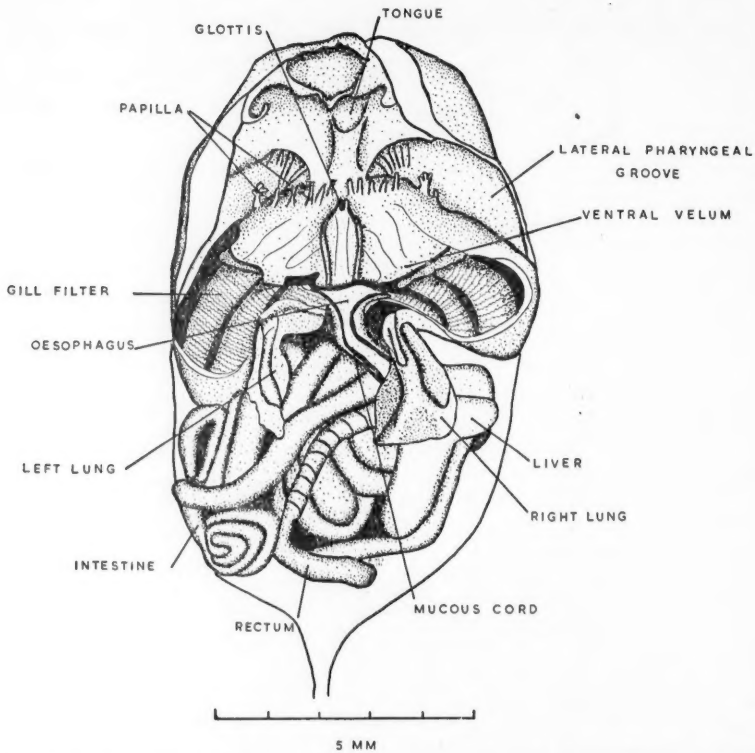

Fig. 2. General view of the respiratory and digestive systems from the dorsal. (Intestines slightly displaced.)

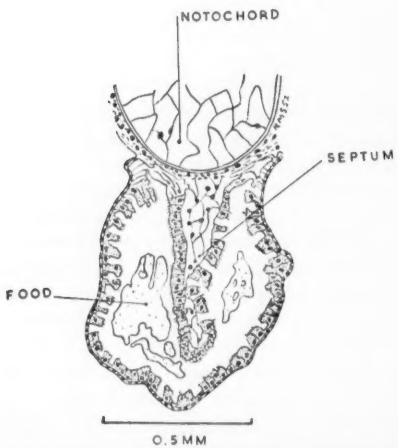

Fig. 3. Oesophagus, showing the septum and the mucous cords.

here, because whatever the function of the organ may be, it is not a stomach, and it seems better to use a word which is free from functional implications. Until now the manicotto has been described only in *Rana*, where it is not ciliated. *H. aguae* has a well developed manicotto (Figs. 4 and 5), in which the extremities of the pillars of tissue which bound the mucus-filled crypts are provided with cilia (Figs. 5 and 6). The structure of the manicotto itself is much as Barrington described for *Rana*. There is a mass of branching crypts, bounded by cuboidal epithelium. The organ appears glandular, and muscle is weakly developed in the wall. No light is thrown by this discovery, on the unknown function of the manicotto; *Rana* and *Bufo* are sometimes microphagous, but only *Rana* has a manicotto. The purely microphagous *H. aguae* again has the same organ. It is, of course, possible that in *Bufo* less

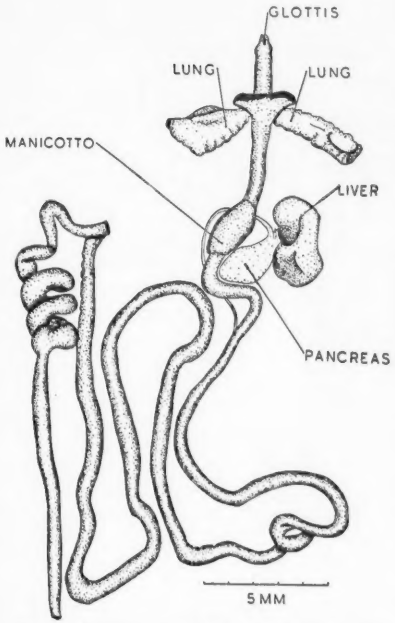

Fig. 4. Alimentary canal and associated organs, with part of the respiratory system.

clearly differentiated tissue performs the same function, but it may be pertinent to point out that *Bufo* appears to utilize its food less efficiently. When tadpoles of both species, hatching at about the same weight, live for the same period in the same pond, taking food which appears to be the same, the growth rate of the bufos is about half that of the ranas (Savage, 1952). Growth rates are, of course, often genetically determined, but there must be a biochemical difference, and this may be the relative efficiency of digestion. The remainder of the gut consists of two portions, the posterior of larger diameter with a spiral portion (Fig. 4). The histology of this part of the gut does not call for much comment. It consists of the usual four layers. The mucosa has a striated border in many parts. The muscularis is so thin that both the longitudinal and the circular fibers are not easily seen in sections cut at right angles to the wall, and may in fact not be both present at any one point, but sections cut almost parallel to it reveal two sets of fibers crossing at right angles.

The coiling of the gut is not the flat type as

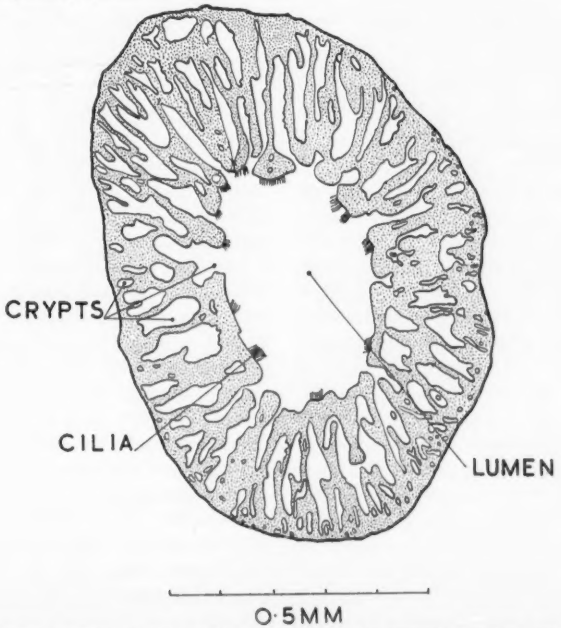

Fig. 5. Transverse section of the manicotto, showing the general structure and the distribution of the cilia.

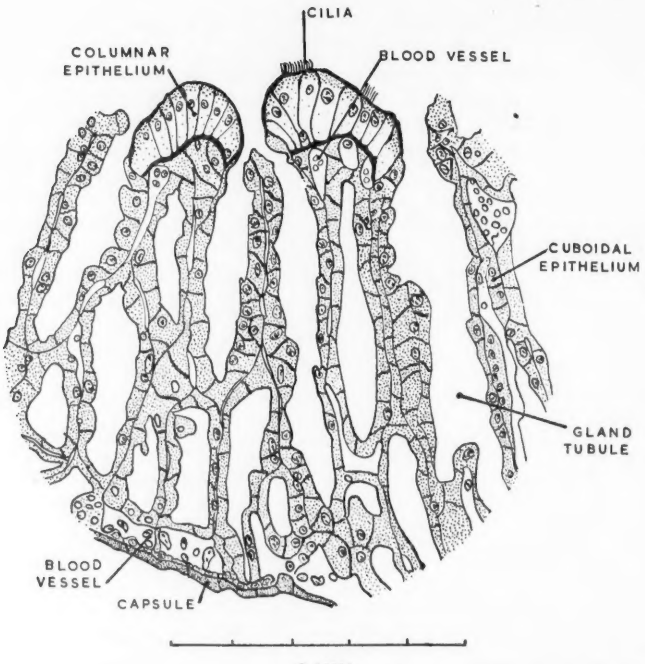

Fig. 6. An enlarged portion of the same section of the manicotto as shown in Fig. 5.

in *Rana* and *Bufo*, but takes the form of a double helix with axis from left to right at right angles to the long axis of the body.

Gills and Gill Filters.—The gills are of the arborescent type, as in other microhylids, and not like those of *Rana* or *Bufo*. They form long filaments projecting into the atrium (Figs. 7 and 8). In *Glyphoglossus molossus* and *Calluella guttalata*, it was found (Savage, 1952) that there were no gills, the tadpoles respiring by means of the hypertrophied gill filters. In *H. aguae* reduction has not proceeded so far, but there are no gills on the first arch and only a few tufts on the fourth. Those on the second arch are in a triple row, but those on the third are only double, and the branching is simpler. The gill filters are of the usual anuran pattern, previously described by Schultze (1888, 1892), and Kratochwill (1933), and the opening to the branchial basket below is closed by the apposition of the end of each row of filters with its fellow on the opposite side, so that when this contact occurs, the water has no way of egress except through the filters and so to the collecting channels below. These in turn lead to a space just above the gills, which is bare of filters (Fig. 9). A sectional view of the branchial basket is shown in Fig. 8. A side view of the branchial basket (Fig. 7) shows that the organ is almost circular. This is almost certainly of hydrodynamical significance, for water entering in the direction of the arrow will swirl round in the basket in a circular direction, and may be expected to impel mucus towards the anterior edge of the ventral velum. The small diagram on this drawing shows the similarity of the general shape of the branchial basket to such an engineering structure as a centrifugal pump or cyclone separator. Each cleft contained a "collecting organ" similar to that described in the other microhylids (Savage, 1952) (Figs. 7 and 10). The state of preservation of the specimens was good, and allowed histological examination to be made. The structure consists of deep columnar epithelium, with goblet cells, but with no cilia .This is surprising, for there are rows of parallel striations on the organ, which

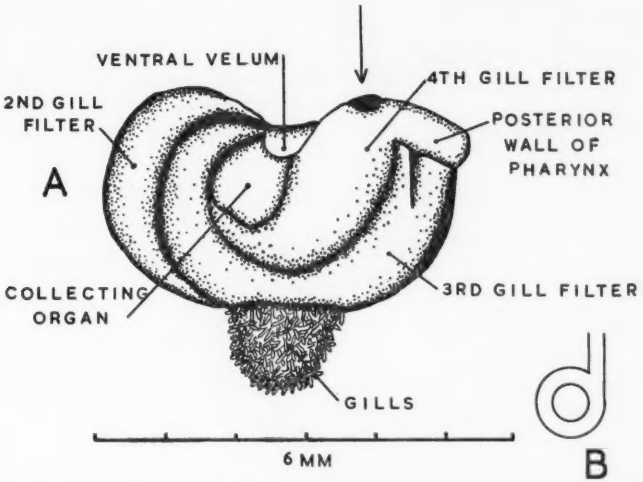

Fig. 7. Right branchial basket viewed from the left side. The arrow shows the route taken by the water. The small diagram, B, is a simplified representation of a common engineering hydrodynamic structure, for comparison.

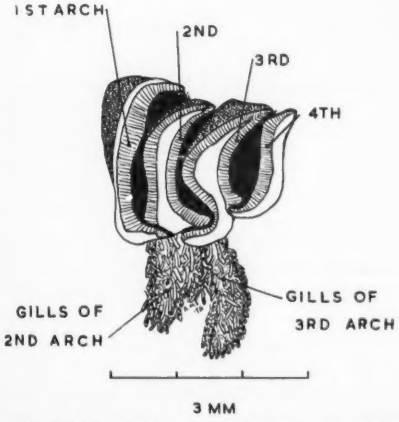

Fig. 8. View of the branchial basket, cut at right angles to the axis of the body, showing gills and water channels.

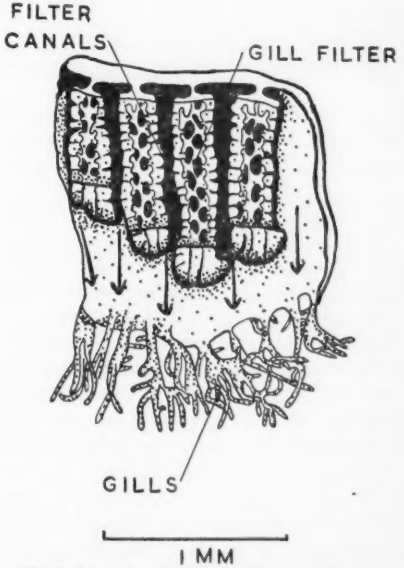

Fig. 9. A portion of a gill filter plate of the second arch. The whole length of the gills is included but some of the hinder filaments are not drawn. In life, the filter canals are probably not open as shown but are roofed in by the filters on each side.

in the less perfectly preserved specimens previously examined were thought likely to be the sites of rows of cilia lost during long storage. Repeated fruitless search has been made in the present sections, stained by the Azan and by other methods, in which other parts of the same section showed well-displayed cilia, and unless there is some special reason for the accidental loss of cilia from these organs, it must be accepted that the striations merely represent lines of cells raised above those of adjacent rows. It would seem that the only means by

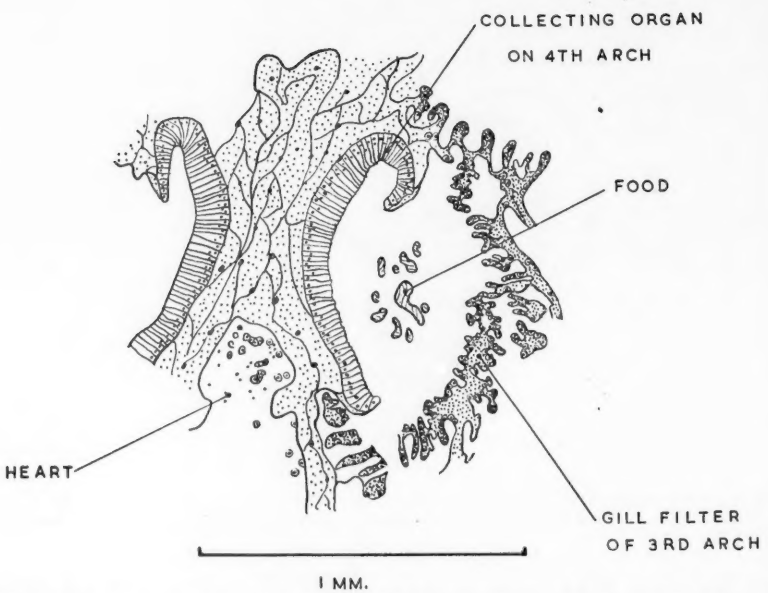

Fig. 10. Section of the anterior portion of branchial basket, showing the collecting organ and its relation to food particles.

which the mucus is propelled to the edge of the ventral velum is by the hydrodynamic action suggested above.

Relation Between Structure and Ecology

From the fact that the animal has reduced gills, but has not eliminated them entirely as in *Glyphoglossus* and *Calluella*, and has small but apparently functional lungs, it was inferred that it probably does not inhabit the highly oligotrophic type of lake, in which the food supply is scanty. Large volumes of water have then to be filtered, so that the gill filter is alone a sufficient respiratory surface. On the other hand the reduction suggests that the habitat is certainly not the small puddle, crowded with food, but poor in oxygen. It was thought that the tadpoles probably lived in a generally well oxygenated, fairly large ordinary pond. This guess was communicated to the collector, Dr. L. C. Stuart, who replied:

> You guessed correctly as to the environment of *H. aguae*. It came from Duenas in Guatemala . . . The pond from which they were taken probably dries up to a marshy condition in the dry season (this owing to drainage projects in the region) but originally it was a small shallow lake of some size. The water is warm and shallow and probably well oxygenated to judge by the abundance of aquatic vegetation. It is polluted by no more than cow dung. The water does not carry much silt in suspension except as a cow may wander through it.

It is obvious that the tadpole is strictly microphagous, for no food particles can pass down the divided oesophagus unless they are very small.

Summary

The tadpole of *Hypopachus aguae* has been found to possess: (1) Reduced gills. The first arch has no gills, and the fourth only rudiments. (2) Fairly well developed lungs. (3) An oesophagus divided into two by a septum, so that the two feeding cords of mucus each has a separate channel. (4) A manicotto similar to that of *Rana*, but ciliated. (5) The collecting organs in the branchial chambers have been examined, and found not to be ciliated. The mucus on it appears to be moved by hydrodynamic action. (6) It is considered that the tadpole is more highly specialised for microphagy than any hitherto described.

ACKNOWLEDGEMENTS

The work depended on a generous gift of tadpoles from Dr. L. C. Stuart. Some of the apparatus was provided from a grant from the Royal Society, which is gratefully acknowledged.

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Life History Patterns of the Salamander *Ambystoma macrodactylum* in the High Cascade Mountains of Southern Oregon

JAMES KEZER AND DONALD S. FARNER

THE life history of *Ambystoma macrodactylum* is one of considerable variability, the details of which are incompletely known. Previous reports have indicated that the time of egg deposition and the length of larval life vary with the altitude. Eggs may be spawned at lower elevations as early as mid-February in either temporary or permanent bodies of water (Fitch, 1936: 636). Metamorphosis has been reported to occur as early as July at sea level or, in the high altitude mountain ponds, to be delayed until the following season (Stebbins, 1951: 39; Slater, 1936: 236).

Our observations were made at localities within and in the vicinity of Crater Lake National Park in the Cascade Mountains of southern Oregon. Previous observations on this species in this area have been summarized by Fitch (1936) and by Farner and Kezer (1953). Within this part of the Cascade Mountains there are several different kinds of bodies of water in which *Ambystoma macrodactylum* breeds. The larvae may be found in Crater Lake, in permanent ponds, in ponds that last for only a few weeks during the summer, and in others that may or may not dry up during the summer months, depending upon the amount of rain and snow. During the summer of 1951, while working on a survey of the amphibians and reptiles of Crater Lake National Park, we were able to make observations on *A. macrodactylum* in these various kinds of aquatic habitats. As our field work progressed, it became evident that the life history of this salamander was even more variable than had been previously suspected. The observations presented in this paper, although essentially fragmentary, contribute to a clearer characterization of the variability of the life cycle of this species.

All of the specimens to which references are made are in the Crater Lake National Park Zoological Collection (CLNP). The locality names are from the United States Geological Survey topographic map, "Crater Lake National Park and Vicinity, Oregon," edition of 1946.

RESUMÉ OF OBSERVATIONS

CRATER LAKE (6,160 feet).—Crater Lake is an extremely oligotropic cold-water montane lake; a littoral zone, in the ordinary sense

of the term, is lacking, the shore line being generally rocky and with few shallow areas. The rather scanty limnological information is reviewed briefly by Farner and Kezer (1953: 440). Adults of *A. macrodactylum* may be found abundantly beneath rocks and driftwood along the shore throughout the summer (Farner and Kezer, *loc. cit.*: 455). Frequently they are associated with the adults of the Mazama newt, *Taricha granulosa mazamae* Myers (Farner, 1946). Usually they are found within a few feet of the shoreline, although we have one specimen taken about 100 feet above the lake level on September 26, 1951. A typical series of ten adult males collected during the summer of 1946 had a mean length of 90 mm. (range 70–130 mm.); a similar series of females had a mean length of 105 mm. (85–120 mm.). Two sizes of larvae have been obtained. During the first week in September, 1951, we obtained two small larvae from a partially cut-off pool behind the government boathouse on Wizard Island; these two larvae (CLNP 451) had a mean total length of 41.5 mm. Elsewhere in the lake we have found only large (about 90 mm.) larvae (CLNP 367, 372) and intermediate stages between these larvae and adults of similar size.

Munson Oxbow Pond (6,230 feet).—This pond occupies a small section of an old channel of Munson Creek. It is about 2 meters in width, about 8 meters in length and has a maximum depth of about 0.6 meter. The water level is constant throughout the summer. It is usually covered with snow from early December until mid-June or early July. The *A. macrodactylum* population of this pond was observed closely during the summers of 1951–52. During both summers the pond contained occasional adults and two distinct size groups of larvae. Between August 15 and 25, 1951, we obtained many small larvae (CLNP 403, 427; 25–38 mm. total length); a single large larva (CLNP 402; 93 mm.) on August 17; and an adult of similar size (CLNP 423; 88 mm.) on August 25. On July 15, 1952, thousands of eggs were seen. They were attached, singly or in small groups, to vegetation along the shore. The degree of development varied from yolk plug to motile embryos. Also collected on this date were three larvae (CLNP 531; 36, 39, 58 mm.), and an adult (CLNP 542; 127 mm.) was found beneath a log along the edge of the pond. On July 18 two sizes of larvae were clearly distinguishable—the abundant smaller larvae had a mean length of about 25 mm., whereas the less common larger larvae were about 80 mm. in length. On August 25 the small larvae had reached a total length of 25–40 mm. Four large larvae (CLNP 564) collected on this date had attained lengths of 77–87 mm. One was partially metamorphosed. Two individuals (CLNP 564; 83, 84 mm.) had completed metamorphosis but were still in the water. Before they were collected they were observed coming to the surface of the pond to gulp air.

On the basis of observations made during the summer of 1951, we concluded that the variation in total length of larvae from the eggs of a single season suggested the possibility of a long period of egg laying (Farner and Kezer, *loc. cit.*: 457). During the summer of 1952, we observed that in the smaller ponds eggs are deposited over a period of only a few days. A partial solution to the problem of length variation of larvae from eggs of similar age was suggested by a clutch that had been deposited in a snow-fed rivulet a few feet from the point where it emptied into Munson Meadow Pond. On sunny days the temperature of the water in the pond was 22°C., whereas the temperature of the tributary rivulet water was consistently 7.8°C. On July 15, 1952 the eggs in the colder water of the rivulet were all in the yolk-plug stage; those in the warmer water of the pond varied in development from yolk-plug to motile embryo. Most of the eggs in the pond had hatched by July 18 and by August 12 the larvae had grown to a mean total length of about 32 mm. On this same date, probably more than a month after they had been laid, the eggs in the rivulet had reached only the tail-bud stage of development. We have no proof that these slowly developing eggs reached the hatching stage, but this low-temperature retardation of their development suggests one possible explanation for the considerable variation in size within a particular age group of larvae.

Arant Point Pond (6,250 feet).—This pond has been described in some detail by Bisbee *et al.* (1951). It is about 80 meters long, 30 wide, and 1–1.5 deep. It is located in a relatively dense forest of Mountain Hemlock, Shasta

Fir, and Lodgepole Pine. On September 5, 1951, four small larvae (CLNP 477; 36–44 mm.) were obtained; a newly metamorphosed individual, 82 mm. in length, was found beneath a rock at the edge. A careful inspection of the pond failed to reveal larvae of this length. On August 10, 1952, two sizes of larvae were seen. Six small larvae (23–32 mm.) were collected. The single large larva seen was about 80 mm. in length. Although the data are incomplete, it appears that the situation in the Arant Point Pond is similar to that in the Munson Oxbow Pond.

THE WHITEHORSE BLUFF PONDS (6,250 feet).—In June and July there are no less than 12 to 15 ponds of various sizes on the flat summit of Whitehorse Bluff. These vary from very small temporary pools a few meters in diameter and a half-meter or less in depth to larger ponds up to 70 meters in length. None is deeper than one meter. Among the larger ponds only two or three ever persist until fall and probably only one ("Permanent Whitehorse Pond") actually persists through every summer. In general, salamander larvae are found only in the three larger ponds.

Observations made in the "North Pond" are of particular interest in terms of information regarding the effect of unfavorable environmental conditions on the length of larval life. Data accumulated from this pond during the summer of 1951 have been presented in detail by Farner and Kezer (*loc. cit.*: 456) and need be summarized only briefly. The "North Pond" was first visited in 1951 on July 22; it had then a maximum depth of about one meter and an area of approximately 500 square meters. Ten larvae of *A. macrodactylum* (CLNP 383) collected during this visit had a mean length of 32 mm. By August 19 the pond had shrunk to a small puddle having a surface about 30 square meters and a depth of only a few centimeters. Ten larvae collected on this date had a mean length of 47 mm. A thorough search of the woody debris around the pond failed to reveal metamorphosed salamanders. During the next 10 days, the "North Pond" dried up and then was partially refilled by the rain and snowfall of August 28. On August 29 many dead salamander larvae were seen on the mud of the shallow pool. On this same date we found five recently metamorphosed salamanders in and under the rotting woody material around the edge of the pond. Two of these had metamorphosed so recently that they still possessed short, unabsorbed gill filaments. The mean length of these five individuals was only 48 mm.

On July 1, 1952 the "North Pond" of Whitehorse Bluff was still mostly covered with snow. During the following 2 weeks, a considerable amount of melting occurred and on July 16 two large adults were observed in the open water. The one that we were able to capture (CLNP 536; 90 mm.) was a male whose sperm ducts contained live sperm but whose testes were reduced to the central duct and the primary spermatogenia. We presume that this individual had already deposited spermatophores. By July 23 the pond contained many eggs deposited singly or in small groups attached to the under surfaces of dead branches, bark, etc., floating near the edge of the pond. All had embryos at least beginning to form gill filaments (CLNP 527). The larvae had not left the eggs by July 27, but on August 3 we captured four small free larvae (CLNP 535; 13–14 mm.). Throughout the summer of 1952 the "North Pond" maintained a good supply of water and by the end of August, when the observations were discontinued, no metamorphosed individuals had been found.

The "Southwest Pond" on Whitehorse Bluff became dry early in the summer of 1951 and there was no evidence of salamanders. On July 1, 1952 this pond was about 70 meters long, 10 wide, and about 0.5 deep; there was still snow around the edges. No eggs, larvae, or adults could be found. On July 27 we found a mass of gel from which the larvae had already escaped. On August 3 we collected 10 small larvae (CLNP 532; 22–30 mm.). On August 8 the pond had decreased to a diameter of 1.5 meters and by August 12 it was completely dry; all of the larvae were dead. No metamorphosed individuals could be found.

We first visited the "Permanent Whitehorse Pond" on August 8, 1952. The principal section of this pond is about 25 meters long, 15 wide and about 0.6 deep with about 1.4 meters of loose mud on the bottom. Around the edge are occasional plants of the bur-reed, *Sparganium angustifolium*, and the bottom is covered with a quillwort, *Isoëtes bolanderi*. On

August 8 two sizes of larvae (CLNP 545) were obtained: two small larvae had total lengths of 17 and 22 mm., whereas four large ones varied from 76 to 82 mm. In addition to the principal section of the pond there are two smaller sections which apparently dry up during the summer. These smaller sections had only small larvae. On August 25 we again found, in the principal section, two sizes of larvae: nine small ones (CLNP 565) varied in total length from 27 to 33 mm.; two large larvae each had a total length of 86 mm. On September 29 two adults (about 88 mm.) were found beneath rotten logs along the edge of the principal section and large numbers of smaller larvae (30 mm.) were observed.

LAKE WEST (5,114 feet).—Lake West is located in Douglas County near the northwest corner of Crater Lake National Park. It is about 150 meters long and 60 wide; its maximum depth is probably about 9 meters. It has pumice-sand beaches. Its vascular flora consists of a rich growth of quillwort, *Isöetes bolanderi*, and occasional plants of water smartweed, *Polygonum amphibium*. During the summer, the shallower parts of Lake West contain innumerable larvae of *Rana aurora cascadae* and *Hyla regilla*. Large numbers of *A. macrodactylum* larvae are found at depths of 1.5 meters or more. Only a single size group occurs. Three specimens collected on July 24, 1952 (CLNP 530) varied in length from 37 to 39 mm. By late August, 1952, the larvae of Lake West had attained lengths of about 60–80 mm. Metamorphosis occurs in late August and early September, at which time amazingly large numbers of recently metamorphosed individuals may be found beneath and within rotten logs along the shore. On September 4 and 9, 1949, it was not unusual to find more than 100 newly metamorphosed individuals within and under a single log. On July 19, 1951, a thorough search of woody material around the edge of the pond yielded only four adults (CLNP 371; 84–93 mm.), but on August 30 this same material contained hundreds of recently metamorphosed salamanders. On this same date, larvae in various stages of metamorphosis were abundant in shallow water near the shore. Ten of the newly metamorphosed individuals selected at random (CLNP 449) varied in length from 64 to 79 mm. On September 4 and 6, 1951, there were again large numbers of recently metamorphosed individuals; 108 were counted beneath a single board 1 foot wide and 12 feet long.

DISCUSSION AND INTERPRETATION

Although the evidence is incomplete, it appears that in this area of the High Cascades there are at least three life history patterns. (1) One season larval period.—This appears to be the situation in Lake West in which only a single size group of larvae occurs. Perhaps the eggs are deposited in May or early June, just as soon as open water is available. Metamorphosis occurs in late August and early September to produce adults with a total length of 60–80 mm. (2) Two-season (or more) larval period.—This is the pattern which occurs in Crater Lake, Permanent Whitehorse Pond, Munson Oxbow Pond, and probably in Arant Point Pond. It appears, at least on Whitehorse Bluff and in Munson Oxbow Pond, that eggs are deposited in early July and the larvae attain a total length of 30–50 mm. by fall. During the course of the second summer they attain a length of 70–90 mm., and metamorphosis presumably occurs before winter. Actually, it is possible that the larval period is still longer, with little or no additional growth. These bodies of water all have two size groups of larvae. (3) Facultative one-season larval period.—This is characteristic of the less permanent ponds on Whitehorse Bluff and possibly of other localities in the park, such as Boundary Springs, where small adults have been found. Apparently, eggs are deposited in July and development proceeds as in the permanent ponds. However, the drying up of a pond in late summer or fall induces metamorphosis of some of the first-year larvae if they have attained a length of about 40–50 mm. It is presumed that growth to the normal 70–90 mm. is then completed after metamorphosis. Direct evidence is lacking that such individuals actually become normal sexually mature adults although the continuance of a part of the Whitehorse Bluff population would seem to require this.

SUMMARY

In Crater Lake National Park and the adjacent High Cascade country of southern Oregon,

Ambystoma macrodactylum appears to show three fairly distinct life history patterns. At lower elevations (about 5,500 feet and less) the eggs are deposited early enough and development is sufficiently rapid so that metamorphosis occurs in early September when a total length of 60–80 mm. is attained. Apparently all larvae metamorphose at this time. Lake West (5,114 feet) probably represents the maximum elevation at which this occurs. In the permanent bodies of water at higher elevations (above 6,000 feet) the eggs are deposited later (probably in July) and development is slower. The larvae attain a length of 35–50 mm. by fall; metamorphosis occurs during the second summer (or perhaps later) when a total length of 70–90 mm. has been attained. In the temporary ponds at higher elevations (above 6,000 feet) the schedule of egg laying and larval development is similar to that of the permanent ponds. However, if a pond dries up after the larvae have reached a total length of 40–50 mm., metamorphosis may occur, producing "small adults" of this length. Although we do not have direct evidence that these "small adults" develop into sexually mature large adults (70–90 mm.), it appears that the maintenance of certain of the populations requires that such must be the case.

ACKNOWLEDGEMENTS

We wish to acknowledge the kind interest and assistance of Park Naturalists Harry C. Parker and George C. Ruhle and Chief Ranger Louis W. Hallock. We are particularly indebted to Edmund J. Bucknall who made collections from some of the ponds during the fall of 1952. Most of the observations were made and specimens were obtained while we were members of the temporary naturalist staff of Crater Lake National Park.

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Early Development of Two Subspecies of the Salamander *Triturus cristatus*

HAROLD FOX

MERTENS and Mueller (1940) listed five subspecies of *Triturus cristatus* (with their geographical distributions) as follows: *T. c. cristatus* (Laurenti), *T. c. danubialis* (Wolterstorff), *T. c. dobrogicus* (Kiritzescu), *T. c. carnifex* (Laurenti) and *T. c. karelini* (Strauch). Wolterstorff (1923) compared the adults of all the subspecies except *dobrogicus*; the latter he called a local form of *danubialis*. The group has been investigated by Wolterstorff and Freytag (1943), Callan and Spurway (1951) and Spurway (1953). Wolterstorff and Freytag studied color patterns as a result of various crosses between some of the subspecies; Callan and Spurway investigated the cytology of hybrids resulting from crosses between *cristatus*, *carnifex* and *karelini*; Spurway, in addition to describing the adult forms in *cristatus*, *carnifex*, *karelini* and *danubialis*, used these subspecies with *T. marmoratus marmoratus* to study viability, physique, fertility and behavior of the hybrids. A normal

series between stages H 36 and H 63 (H = Harrison series for *Ambystoma maculatum*. See Hamburger, 1950: Fig. 45) for *T. c. cristatus* (Laur.) from the Freiburg area has been worked out and illustrated by Glücksohn (1931), using as a criterion the development of the limbs.

However it seems that little has been reported of any differences between these subspecies relating to their early development. Embryos of two of these, *carnifex* and *karelini*, have been employed by the writer to investigate certain aspects of the development of the pronephros, and several features relating to their early development may be of interest to systematists and embryologists.

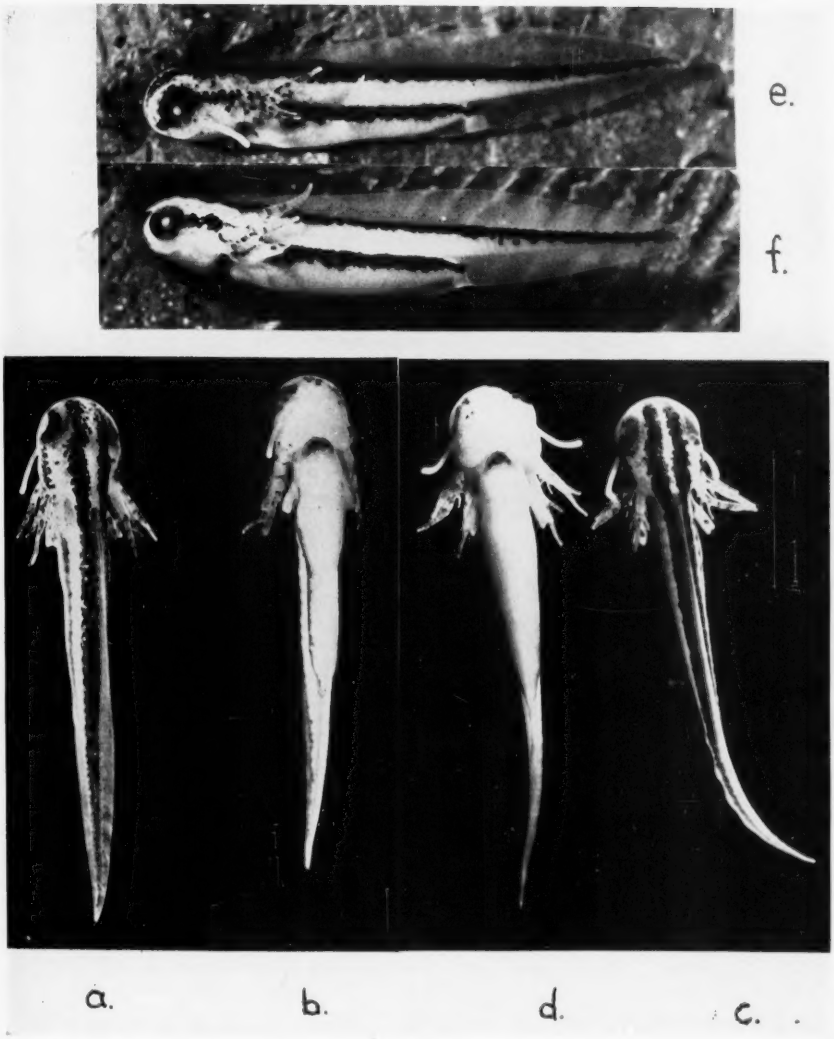
The eggs of both subspecies are deposited usually singly but often two and occasionally possibly three to each leaf (*Hygrophila* and *Ludwigia*). The leaf is folded over by the female and the edges sealed by some sort of albuminous secretion. The egg is thus contained in a sealed "purse." Leaf purses of *karelini*, in my experience, were more difficult to separate than those of *carnifex*, suggesting that the albuminous secretions were of a different adhesive nature.

In general the appearance and the development of the eggs of the two subspecies are similar. They hatched naturally about 12 days after spawning had occurred, the corresponding stage being about H 38/39, equivalent to Stage 39/40 in *T. c. cristatus* (Glücksohn, 1931) and to Stage 28/29 in *T. alpestris* (Knight, 1938). The total length varied approximately between 9.0 and 9.5 mm. (Plate I). Development took place in London tap water with the temperature between 18° and 23°C. No significant differences in size or rate of development appeared obvious under these conditions, but it should be emphasized that only crude measurements were made. Pigment is laid down in both species in a particular constant pattern. It is laid down antero-posteriorly in two longitudinal black bands along the dorsal side of the head, as a single dorsal black band along the back, on each side running along the side of the body above the yolk, and as a small patch in the throat region. Later when the larva is about 10 mm. in total length, and soon after the time of hatching, pigment is deposited in the tail fin as a series of scattered black spots appearing to be distributed at random (equivalent to H 42, approximately). This pigment becomes more profuse as development proceeds. There does not appear to be any obvious difference in the amount, or rate, of deposition of pigment in the two subspecies. The onset of pigment deposition in the tail is variable even among members of the same subspecies. Sometimes there is more pigment present in a 9.5-mm. specimen than in a 10-mm. one.

One difference between the eggs of the two subspecies was recorded. My experiments on the pronephric blastema were performed at the early caudal bud stage (corresponding to H 23–25). The eggs of *Triturus* have an outer capsule with an external sticky membrane, then internally an inner capsule, and between this and the vitelline membrane surrounding the developing embryo is the intracapsular fluid. Decapsulation is notoriously difficult in species of *Triturus* especially up to the tail bud stages (Hamburger, 1950: 39); however, with *carnifex*, decapsulation in full-strength Holtfreter solution offers no serious problems providing the right techniques are employed. In *karelini*, however, I found that even as late as the stage corresponding to H 30 decapsulation was nearly always accompanied by bursting of the embryo, with damage and subsequent death. Dr. D. R. Newth of this department has informed me that he had no success at all decapsulating *karelini* at the blastula stage, but that perfectly satisfactory decapsulations were obtained with blastulae of *carnifex*.

The embryonic tissues of *karelini* appeared to me more delicate and easily ruptured than those of *carnifex* as late as the first stages of pigment formation (corresponding to H 27/28). The embryos were only successfully removed from the capsule 2 to 3 days after the caudal bud stage, when it had lengthened, was pigmented, U-shaped and reacted to external stimulation by wriggling movements.

It appears possible that intracapsular pressure is significantly different in the eggs of the two subspecies. This could be a subspecific difference, but the assumption is not necessarily true. Certainly a difference has been demonstrated between certain females. If this difference between *karelini* and *carnifex* is reported again, and if it has the same geographi-



Larvae of *Triturus cristatus carnifex* and *T. c. karelini*.

a.—Dorsal view of *carnifex*, 9.5 mm. long; just hatched. b.—Ventral view of *carnifex*, 9.0 mm. long; just hatched. c.—Dorsal view of *karelini*, 9.5. mm. long; 24 hours after hatching. d.—Ventral view of *karelini*, 9.5 mm. long; 24 hours after hatching. e.—Side view of *carnifex*, 9.5 mm. long; just hatched. f.—Side view of *karelini*, 9.5. mm. long; 24 hours after hatching.

cal distribution as the skin characters which are used to differentiate subspecies, then this difference may be subspecific. As Hamburger wrote (1950: 15), "One can by no means suppose *a priori* that two even closely related forms will behave alike in a given experiment."

The plentiful supply of eggs of *carnifex* and *karelini* I owe to the generosity of Dr. Helen Spurway of the Department of Biometry and Genetics, University College, London. She kindly informed me that the *karelini* material (11 females) was received from Dr. C. Kosswig of Istanbul, in March, 1953. The *carnifex* eggs were from Family 52A which was used by Dr. Newth and myself for various experimental purposes. The family was from a single pair (♀ 46 × ♂ 39) that had been received with other newts from Prof. G. Montalenti of Naples in November, 1950. The *karelini* eggs were obtained at random from the eleven females.

The observations were made in the Spring of 1953, the study being supported by a grant from the Agricultural Research Council, England.

I am grateful to Dr. Spurway and Prof. J. B. S. Haldane, F.R.S., for their views on the subject, and to Mr. W. Brackenbury of the Department of Zoology, University College, London, for his photographic work.

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Pleistocene Lizards from San Josecito Cavern, Mexico, with Description of a New Species

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While searching for fossil rattlesnakes in the various vertebrate paleontology collections, the writer found some lizards from the Pleistocene of San Josecito Cavern in the collection of the California Institute of Technology. San Josecito Cavern is located in the Province of Aramberri, Nuevo León, Mexico. The elevation of the cave is 7,700 feet above sea level, and the cave opens on the east flank of the Sierra Oriental in a limestone scarp surrounded by a pine and live-oak plant association. The deposit was discovered by the late Dr. Chester Stock of the California Institute of Technology.

Fauna and Age

The larger mammals of the San Josecito Cavern deposits have been identified by Stock (1942, 1943, 1948), and these include dire wolf (*Canis dirus*), sloth (*Nothrotherium*), horse (*Equus*), antelope (*Tetrameryx*), and three large cats (*Felis atrox, F. onca,* and *Smilodon*). The rodents and lagomorphs have been studied by Cushing (1945), the shrews by Findley (1953), and the birds by Miller (1940, 1942, 1943) and Howard (1940). Most of the birds found are raptors. Of the 40 identified species, four are known only from San Josecito Cavern, 22 are also found in the La Brea Asphalt, and

12 of the 40 are extinct (Miller, 1943). The fossil birds include *Teratornis*, *Spizaetus*, *Wetmoregyps*, *Neogyps*, *Neophrontops*, and *Meleagris*.

From the above fauna it is apparent that the cavern deposits are Pleistocene, possibly early or middle.

Herpetofauna

Though a large number of small bones, including rodents, were discovered in the diggings of San Josecito Cavern, the only reptiles or amphibians found in the California Institute of Technology collection were two specimens of horned lizards, *Phrynosoma*, representing two species, one of which is described herein as new.

Phrynosoma orbiculare (Linnaeus)

One fragment, 8.2 mm. long and consisting of three left temporal spines, is quite obviously *P. orbiculare*. The posterior spine is the longest, but only slightly longer than the next. The most anterior temporal spine is the shortest. The two posterior spines together measure 5.2 mm. at the base and 3.6 mm. between the tips. The length and width of the three spines (from posterior to anterior) are 4.8 × 2.5, 4.4 × 3.5, and 2.7 × 3.3 mm.

Phrynosoma josecitensis, sp. nov.

Type.—California Institute of Technology (CIT) number 192/5116, consisting of a fragment 9.5 mm. long of four right temporal spines.

Locality and Age.—CIT locality 192, Pleistocene, San Josecito Cavern, Nuevo León, Mexico.

Diagnosis.—A *Phrynosoma* with four temporal spines, differing from existing species with four temporal spines by their shape, having two posterior spines which are long and narrow and having two short, stubby, and thin anterior ones.

Description of Type.—A fragment 9.5 mm. long consisting of four right temporal spines whose lengths and widths (from posterior to anterior) are 4.3 × 2.3, 4.0 × 2.6, 2.3 × 2.2, and 1.6 × 2.0 mm. The two posterior spines measure 4.4 mm. at their combined base and 3.4 mm. between their tips. The two most posterior spines are long and narrow, and the two anterior ones are short, stubby and thin. The third spine posteriorly curves caudad slightly and the next spine anterior to it appears slightly broken. There is a small spine or bump dorsal to and between the two posterior spines.

Phrynosoma josecitensis differs from most other *Phrynosoma* in having four temporal spines. *P. josecitensis* differs from *P. platyrhinos* in that both the posterior spine and the anterior one are longer. From *P. coronatum* it differs in that the posterior two spines of *josecitensis* are almost equal in length and are thinner. The most anterior spines of *josecitensis* are more fully developed than in *coronatum*. *P. josecitensis* appears to be closely related to *P. solare* which lacks an anterior temporal spine. If the most posterior spine of the fossil corresponds to one of the lateral occipital spines of *solare* (which I doubt), then they still differ; *josecitensis* has the anterior two temporal spines shorter than *solare*, and the lateral occipital spine is not raised above the level of the temporals (as it is in *solare*).

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Herpetological Notes

AN ADDITION TO THE LIST OF PALLID ANIMALS OCCURRING IN WHITE SANDS NATIONAL MONUMENT.—There is a long list of invertebrate and vertebrate animals of the New Mexican Tularosa Basin in which populations of pallid individuals occur on the famous white sands. Among the amphibians and reptiles, five species (*Scaphiopus couchi, Holbrookia maculata ruthveni, Uta stansburiana stejnegeri, Sceloporus undulatus consobrinus,* and *Cnemidophorus inornatus*) have been reported to have "white" forms in the dunes. The subject of this note is a single specimen of *Scaphiopus bombifrons* captured at night on June 27, 1954, near the public campground within the Monument. This frog was found sitting on the road after a shower. The specimen, 43 mm. from snout to vent, was so light at the time of its capture that the dark eyes and black cutting tubercles were strikingly pronounced. Kept in a moist collecting bag, the frog darkened to a yellow-brown, but the specimen (now Illinois Nat. Hist. Surv. No. 7480) is considerably lighter in color than any other preserved specimen of *bombifrons* in the collection.

Several of the populations of invertebrates (regarded as species) and mammals (regarded as races) endemic to the White Sands have been named. Of the four lizards and two amphibians known to have "white" forms, only one (*Holbrookia maculata ruthveni*) has received a name; that name has been generally accepted. There is, however, as much justification for naming the pallid forms of *Uta stansburiana, Sceloporus undulatus,* and *Cnemidophorus inornatus,* all of which apparently occur throughout the Monument. The hesitation in naming these lizards is probably due to the reluctance of most herpetologists to recognize small, localized populations. Moreover, it would follow that the dark representatives of the three last-named species on the adjacent black lava Malpais (Lewis, 1949, Copeia, (3): 181–4) are equally deserving of recognition. Captive specimens of the white lizards, unlike the *Scaphiopus,* retain their light colors in varied environmental conditions, suggesting that the bleached coloration is fixed genetically.—Philip W. Smith, *Illinois Natural History Survey, Urbana, Illinois.*

OBSERVATIONS ON THE BLUE-TAILED SKINK, *EUMECES FASCIATUS,* CAPTURED IN RONDEAU PARK, ONTARIO AND KEPT IN CAPTIVITY OVER WINTER.—During the week of September 20 to 26, 1953, three blue-tailed skinks, slightly less than 3 inches long, were captured in Rondeau Park, in southern Ontario. They were found beneath loose bark on fallen logs lying in weed-grown fields beneath a growth of scattered tall trees. They displayed the typical coloration of young *Eumeces fasciatus* with the general body color jet black, the five longitudinal stripes distinct and yellowish, the tail a bright azure blue and the ventral surface dusky white.

The skinks were kept over winter at room temperature in London, Ontario, in a half-gallon jar covered with a perforated lid. Chunks of wood, twigs and flat pieces of bark placed in the jar served as shelters for the skinks, and the contents of the jar were kept damp with water sprinkled into it. The skinks usually remained under these shelters, but when the light of a desk lamp was trained on a slab of bark in the jar they would leave their hiding places and assemble on the bark, huddling against one another as close as possible to the source of heat.

The skinks were fed on living insects. During the fall, blowflies (*Phormia regina*), cluster flies (*Pollenia rudis*), and biting stable-flies (*Stomoxys calcitrans*) were introduced into the jar. A motionless fly did not attract attention, but one moving over the bark or twigs or buzzing about in flight was immediately snapped up and swallowed by a skink. During the winter the skinks ate laboratory-bred cockroaches (*Blattella germanica*) which are about three-quarters of an inch long. A skink would grasp a cockroach by its anterior or posterior end and slowly gulp it down, being capable of ingesting the complete insect. Sometimes two skinks would grasp a single roach, eventually tearing it apart and ingesting the pieces. Occasionally a skink would eat a sowbug (*Oniscus asellus*), but not millipedes, centipedes or slugs. Egested material consisted of loose pellets one-half inch long and one-eighth inch wide made up largely of wings, legs and other hard parts of ingested insects. Each pellet had, at one tip, a white cluster of excreted crystals about one-eighth of an inch long. Some of these clusters were subjected to the murexide test (Harrow, B. 1951: Textbook of biochemistry. W. B. Saunders Co., Philadelphia. 5th ed.) and gave a strongly positive indication of the presence of uric acid. E. Baldwin (1952: Dynamic aspects of biochemistry. Cambridge Univ. Press.) pointed out that the excretion of snakes and lizards contains a large proportion of uric acid, e.g. 91 to 98 percent.

In the middle of October one skink escaped from the jar and was discovered on the floor a few hours later. When an attempt was made to capture it, the skink snapped off the terminal one inch of its tail and wriggled free. However, it immediately turned around, and grasping the severed tail by its narrow end, gulped the whole thing down. The stub of the

tail bled for a few hours but healed over in 5 days. By the end of October a conical, gray growth of new tail about one-eighth of an inch long had formed and by the middle of March, 1954 had grown to three-quarters of an inch in length and had become suffused with the usual blue color. The tails of the other two skinks grew noticeably in length during their captivity. In one of them a terminal piece of regenerating tail, about one-quarter inch long, grew at an angle of 45 degrees from the rest of the tail.

Moulting of the scaly covering of the body occurred in two of the skinks during February 14 and 15, 1954. Scattered patches of loose scales separated from the body, and a long conical sheath of loose scales encasing the tail was gradually sloughed off. Glove-like coverings of loose scales over the legs and feet were gradually scuffed off as the skinks moved about. After moulting the skinks were noticeably brighter in color than previously.—W. W. JUDD, *Department of Zoology, University of Western Ontario, London, Ontario.*

POLYDACTYLISM IN A SECOND SPECIES OF AMPHIBIA IN MUSKEE LAKE, COLORADO.—Polydactylism and limb duplication were reported in a population of *Ambystoma tigrinum*, the tiger salamander, in Muskee Lake, Colorado, by Bishop and Hamilton (1947, Science 106: 641–2). The authors considered this to be the first record of mass polydactylism in amphibians. They collected 24 individuals showing the abnormalities and representing a total of three generations. I collected five more salamanders showing the same condition in 1950 and 1951. Also during these two summers, three leopard frogs, *Rana pipiens*, were found, all of which displayed polydactylism. One of the frogs also had a badly deformed right hind leg, similar to some of the peculiar limb structures known for the Muskee Lake salamanders. As in all the salamanders collected in this lake, the abnormalities in the frogs were also in the hind legs only. From all appearances similar, if not identical, anomalies were present in both species.

Bishop and Hamilton were inclined to think that the abnormality was controlled by a genetic mechanism, presumably a mutation in the population that they studied. This seemed reasonable since similar bodies of water in the area do not appear to have produced any polydactylous individuals and the lake itself was not known to possess any unique physical or chemical characteristics capable of inducing such conditions. A program for breeding was proposed in 1947, but as yet no results have been published. The presence of the condition in the frogs throws considerable doubt on a genetic interpretation, since the probability of the occurrence of a mutation of this sort in two species in the same place and at the same time is unquestionably low; however, it is conceivable. To test this, it was intended to use the polydactylous frogs in a breeding program; a laboratory accident, unfortunately, killed all the specimens.

An explanation may possibly lie inextricably hidden in the complex and unknown factors causing some observable changes in the flora and fauna of the lake. Since 1951, the submerged aquatic flora has changed noticeably, with some species more abundant and others very much less so—some once numerous invertebrates are now difficult to find in the lake; and the frogs and salamanders, formerly numerous, are now markedly less in numbers. There is, of course, no way of knowing at present if these changes and the limb abnormalities are correlated in any manner. It would be interesting to know if these peculiar conditions of the posterior limbs still exist in this amphibian population. In the summer of 1953 three trips to Muskee Lake did not yield any specimens showing the condition.

The author's collection of polydactylous salamanders has been deposited at the University of Colorado Museum, Nos. 6701 through 6705. This museum also has the only remaining anomalous frog from the collection, No. 6706.—WILLARD N. ROSINE, *Department of Biology, University of Colorado, Boulder, Colorado.*

AN ANOMALY IN THE VENOUS SYSTEM OF A MATURE FROG, *RANA GRYLIO*.—A freshman biology student reported to the junior author that his frog lacked a ventral abdominal vein. A skeptical examination revealed that such was truly the case. Instead of a typical venous system, considerable abnormality existed which the authors believe would be of interest to other biologists. The specimen was rescued but not before it had become somewhat mutilated. The frog was a mature male *Rana grylio*, measuring 11 cm. from snout to vent. It was obviously in good physical condition and well adjusted to its circulatory anomaly.

No trace of a ventral abdominal vein could be found in this specimen. Blood from the posterior portions of the body was collected by the two pelvic veins, which then joined near the midline of the body, as is the usual condition (Fig. 1). The single vessel, thus formed, then turned to the left, passed along the inside of the body wall for a short distance and then obliquely entered the muscular tissue of the body wall. The vein then emerged from the musculature on the left side and ran anteriorly between the musculature and the skin. It passed to about the level of the left foreleg, where it entered the body cavity, received a large vein from the foreleg and shortly joined the sinus venosus with the left anterior vena cava. Along its entire length the vein was large and apparently capable of carrying

Fig. 1. Diagram of the dorsal view of the anomalous portion of the venous system in a specimen of *Rana grylio*. A.V.C., (left) anterior vena cava; S.V., sinus venosus; Plv., pelvic vein. Only those veins accurately identifiable are labeled. The unlabeled vein (upper left) may be the left brachial vein. All structures to the right of the dotted line are inside the body cavity; those to the left are outside the body cavity

the same amount of blood as a normal ventral abdominal vein. Small veins from the skin and musculature of the body wall also joined the aberrant vessel. The vein was draining, therefore, those areas normally served by the ventral abdominal and cutaneous veins. From all appearances the vessel from the foreleg is a typical brachial vein except that the proximal portion is enlarged considerably more than a normal one. An examination of the remaining vessels of the circulatory system did not reveal further abnormalities.

The specimen has been deposited in the University of Colorado Museum (No. 6707).—WILLARD N. ROSINE, *Department of Biology, University of Colorado, Boulder, Colorado,* AND PAUL F. BRANDE, *Department of Zoology, Kansas State College, Manhattan, Kansas.*

FOUR RECORDS OF THE ATLANTIC RIDLEY TURTLE, *LEPIDOCHELYS KEMPI*, FROM NOVA SCOTIAN WATERS.—The only mention of an Atlantic ridley turtle (*Lepidochelys kempi*) in Canadian waters appeared in a note by H. J. Squires on marine turtles in Newfoundland waters (1954, COPEIA, (1): 68). This tentative report was based on a fisherman's observation of a "large grey turtle." However, examination of three specimens of turtles in the Nova Scotia Museum of Science and one at the National Museum of Canada has shown them all to be *Lepidochelys kempi* (Garman). They were all labelled *Caretta caretta*.

Each specimen has the four enlarged inframarginal laminae and, on the two individuals which have not been painted, a pore is evident near the posterior margin of each of the inframarginals. The carapace of each is nearly round in outline as is indicated by the length/width ratios of 1.06, 1.06, 1.08 and 1.09. Dissection of the National Museum specimen showed that the two maxillary bones were separated by the vomer which was in contact with the premaxillary bones.

Two of the turtles were collected in 1910. On August 15 one (length 247.7 mm., width 231.8 mm.) was taken near Lahave Island, Lunenburg County, and sent to the National Museum in Ottawa. On August 23 the second (length 263.5 mm., width 239.7 mm.) was collected at Spry Harbour, Halifax County (Report Prov. Mus. and Sci. Library, 1910, p. 11.) The other two specimens are dated 1928 and were both taken from the Bay of Fundy. On October 14 one (length 288.9 mm., width 266.7 mm.) was found near Margaretsville, Annapolis County (Report Prov. Mus., 1928, p. 14). The second specimen (length 269.9 mm., width 254.0 mm.) for that year, taken about October 18, is merely labelled "Bay of Fundy, collector unknown" (Report Prov. Mus., 1931–32, p. 22).

In the 1933–34 Report of the Provincial Museum there is mentioned a 14-inch-long loggerhead turtle, but the specimen was not kept. Its small size opens the possibility of it being either an Atlantic ridley or a loggerhead.

With the correct identification of these four Atlantic ridley turtle specimens, there remains only one authentic record of the loggerhead turtle for Canadian Atlantic waters and that is Squire's (*loc. cit.*) specimen (length 59 cm., width 50 cm.) from the Grand Banks of Newfoundland. —SHERMAN BLEAKNEY, *National Museum of Canada, Ottawa, Ontario.*

UNUSUAL ITEM OF FOOD FOR THE GOPHERSNAKE *PITUOPHIS CATENIFER*.—The following circumstantial evidence points to the swallowing and subsequent regurgitation of two scientific study skins of the piñon mouse (*Peromyscus truei*) by a gophersnake (*Pituophis catenifer*).

A number of mammal skins pinned to a corrugated sheet were placed on the upper shelf of a built-in-cupboard in a student laboratory to dry. About 10 days later when they were to be transferred to a specimen case, I noted that the skins had been disturbed; some of the pins had been loosened, a wood rat skin was completely free with the leg wires bent, and two skins of *Peromyscus* were missing. About a week later a live gophersnake was found on the bottom shelf at the opposite end of the same 12-foot cupboard. At this time, I assumed the snake was the same one a student had reported seeing in the laboratory some weeks earlier and that

its crawling over the skins explained the damage to them, though it did not account for the missing ones. The snake was placed in a cage in the laboratory for students to observe. A week later it was dead and was put into the deep freeze for future study. Some weeks later still, the remains of the two missing skins were found in a shallow carton on the shelf above where the snake had been found.

The skins were entirely dry, but had the appearance of having been coated with mucous that bound the two of them into a single tubular piece. They were stuck together end to end with the ventral part of the hind quarters of one overlapping and molded to the ventral surface of the head of the second for three-quarters of an inch. The former showed the most digestive action. The head was smoothly tapered and showed no features such as mouth, eyes, and ears; the hair was missing from part of the back; the fore limbs were lacking; the left hind leg had the mounting wire protruding at both ends, and the right leg had it protruding at the proximal end; the normal attachment of the legs to the trunk was destroyed but they were adherent to the skin; and the tag was missing. The second specimen showed less digestive action. The features of the head could be made out; the limbs were in place with the rusted pins for the hind legs still in position; and the tag was present, stiffened and somewhat crumpled, but decipherable. The tails in both specimens were curved and twisted. A small amount of white granular material typical of the excrement of reptiles was on the carton next to the skins.

The gopher snake was 56 inches long. Dissection of the digestive tract showed nothing in the stomach and about 10 cc. of a soft curdy material, digested or macerated beyond recognition, in the intestine. There were no pins or wires and no apparent punctures of the intestine or evidence of any damage that might have caused the snake's death.—MARY M. ERICKSON, *Department of Biological Sciences, University of California, Santa Barbara College, Santa Barbara, California.*

THE CHORUSFROG *PSEUDACRIS BRACHYPHONA* IN NORTH CAROLINA.—*Pseudacris brachyphona* (Cope) has been reported from southern Pennsylvania southwestward into northern Mississippi and Alabama (Wright and Wright, Handbook of frogs and toads, 1949, p. 229). The species has not previously been recorded from North Carolina, whence a small series has recently been taken.

On February 20, 1954, after a heavy continuous rain from before dawn until 2:30 PM, *Pseudacris brachyphona* was heard calling and was collected at a locality 2.4 mi. SE of Murphy, Cherokee County, North Carolina, on the flood plain of the Hiawassee River (elevation approximately 1,500 feet). A chorus of about 35 males was heard calling sporadically at about 6:45 PM. Individuals were heard in a small ditch on the upper side of a dirt road at the above locality, and also in a flooded pasture below the road. At the same locality small numbers of *Hyla c. crucifer* and *Rana s. sylvatica* were chorusing, and 26 *Ambystoma maculatum* were taken in congress both in the ditch and in the flooded pasture. The air temperature was 15° C and the temperature of the water (which was flowing slowly) in the ditch was 10° C.

Of the 13 specimens taken (ChM 54.32.11), one is a female. A pair in amplexus was taken in the ditch at 6:45 PM; no other mated pairs nor eggs were seen in the course of two hours' collecting. The frogs were extremely shy and difficult to secure. The males were calling from beneath dead leaves in the water along the margin of the ditch and were hidden in the short grass of the pasture with only the head protruding above grass and water.

The single female measures 31 mm. in snout–vent length, and 14 mm. in length of tibia. The twelve males average 27 mm. in snout–vent length (range 24 to 32 mm.) and 12 mm. in length of tibia (range 10 to 13 mm.).

On the same evening at 8:45 PM, on the road from Murphy to Ducktown, Tennessee, a loud and concentrated chorus of *P. brachyphona* was heard. At this locality 6 mi. SW of Murphy, the frogs were calling from running water at the opening of a culvert at the base of a steep road embankment. About 30 males were heard, but the very dense vegetation prevented collecting.

J. C. Nicholls of Murphy, North Carolina, has told me that he has taken this chorusfrog in the vicinity of Andrews, Cherokee County, North Carolina; this extends the known range of this frog about 17 miles farther northeastward from Murphy in North Carolina.

Wright and Wright (*op. cit.*, p. 231) indicated that breeding in this species occurs from March to July; however, they cited a record (Welter and Carr, 1949, COPEIA, (2): 129) of breeding as early as February 12. Early breeding in *P. brachyphona* would be expected in the more southern population because of earlier mild temperatures in the south.—ALBERT SCHWARTZ, *Charleston Museum, Charleston 16, South Carolina.*

SMALL HERPETOFAUNA FROM THE PLEISTOCENE OF CARPINTERIA, CALIFORNIA.—At the time of previous reports on some Pleistocene reptiles and amphibians from California (Brattstrom, 1953, Trans. San Diego Soc. Nat. Hist., 11 (14): 365–92; 1953, COPEIA, (3): 174–9), no material had been found in Museums from the diggings of the Carpinteria asphalt, Santa Barbara County, California. Recently the writer

found a few reptiles from the Carpinteria Pleistocene in the vertebrate paleontology collections of the California Institute of Technology and the Santa Barbara Natural History Museum.

The Carpinteria deposits are probably late Pleistocene, as suggested by the fauna which consists of *Felis atrox*, *Urocyon cinereoargenteus*, *Canis dirus*, *Camelops?*, *Bison?*, *Equus occidentalis* (Stock, 1927, Science (n.s.), 66: 155–6; Wilson, 1933, Carnegie Inst. Washington Publ., 440 (6): 60–76), *Ciconia maltha*, *Coragyps occidentalis*, *Teratornis merriami*, *Neogyps errans*, *Neophronlops americanus*, *Welmoregyps daggetti*, *Parapavo californicus*, and *Polyborus prelutosus* (Miller and De-May, 1942, Univ. California Publ. Zool., 47 (4): 47–142).

The flora includes *Pinus muricata*, *P. remorata*, *P. radiata*, *Pseudotsuga*, *Sequoia sempervirens*, *Cupressus*, *Arctostaphylos*, *Ceanothus*, *Quercus agrifolia*, and *Juniperus* (Chaney and Mason, 1933, Carnegie Inst. Washington Publ., 415: 45–79).

Though the herpetofauna reported herein consists of only a few forms, it does suggest a climate compatible with the botanical evidence of a moist coastal area similar to that found between Monterey and San Francisco, California, today.

List of Species

Sceloporus occidentalis Baird and Girard.—There are two fragmentary dentaries of this lizard in the California Institute of Technology collection (Locality 139). The posterior teeth are trifid and the two fragments measure 8.0 and 8.1 mm. long.

Elgaria multicarinata (Blainville).—There is one frontal of an alligator lizard in the California Institute of Technology collection measuring 9.9 mm. long. It does not differ from recent *E. multicarinata*.

Coluber constrictor Linnaeus.—There is one small vertebra of this species in the California Institute of Technology collection which is distinguished from other snakes by being elongated, of medium size, having a low neural spine, a narrow (across) postzygapophysis and a wide prezygapophysis, and no strong sub-centrum keel.

Thamnophis sp.—There are three small vertebrae of gartersnakes in the California Institute of Technology collection. They are small, and the hyapophysis is broken in all. I have not been able to find any differences between the vertebrae or skulls of recent species of *Thamnophis*, hence the fossils are identified generically only. *T. elegans* and *T. sirtalis* occur in the area today.

Clemmys marmorata (Baird and Girard).—There are many fragments of almost all the shell bones of pond turtles from the Carpinteria asphalt in the California Institute of Technology collection. These include Carpinteria localities 139 (1′–3′), 6B36½, 1C3 (8′–9′), and 6B38.

In the Santa Barbara Natural History Museum there is one hypoplastron and inguinal buttress and nine marginals plus many fragments of *C. marmorata*.

None of the California Pleistocene *Clemmys marmorata* (La Brea, McKittrick, and Carpinteria) appear to differ from recent *C. marmorata*.

In the Santa Barbara Natural History Museum collection there is a complete carapace and plastron of *Clemmys marmorata* from an Indian burial site in Carpinteria. This pond turtle comes from Santa Barbara Museum Locality 1, Section II, Cemetary A, Burial 1.—Bayard H. Brattstrom, *Department of Geology, California Institute of Technology, Pasadena 4, California.*

RATTLESNAKE HYBRIDS: *CROTALUS VIRIDIS* × *CROTALUS SCUTULATUS*.—Interspecific hybridization in rattlesnakes has been previously observed (Perkins, 1951, Herpetologica, 7: 146), and even intergeneric hybridization has been reported (Bailey, 1942, Amer. Midl. Nat., 76: 376–85). It is seldom, however, that the opportunity is available to follow this phenomenon from the time of copulation of the parents through the birth and growth of the offspring. Herewith is presented an account of the parental history and a summary of the juvenile characteristics of a successful crossing of *Crotalus viridis oreganus* with *Crotalus scutulatus scutulatus*.

The female, *Crotalus s. scutulatus*, was collected on May 3, 1952, on U. S. Highway No. 6 one mile north of the city limits of Mojave, Kern County, California. The male, *C. v. oreganus*, was collected on the northwest slope of Mt. Diablo, Contra Costa County, California on April 16, 1952.

Both snakes were put in an 8′ × 5′ indoor cage containing many *Crotalus v. oreganus* which were being utilized for other work. Since favorable conditions were provided by means of a sunlamp and adequate food, water, and ventilation, it was not unusual to see copulation occurring from time to time. The two snakes concerned were observed copulating on approximately May 10, 1952.

On an unrecorded date in late September or early October of the same year, parturition was observed. When first noticed in the middle of the morning, the female had already given birth to five of the future litter of twelve. The last one was born in the middle of the afternoon. Each young snake was delivered, coiled in a transparent membranous sac from which it emerged a few minutes thereafter.

When the litter was complete, all the newly born snakes were taken from the larger cage and put in smaller tanks. Within a week the young had all shed their skins and were starting to feed on small mice.

Only one refused to eat, and it died shortly after birth. Unfortunately it was not saved. Only three remain alive at this writing, nearly two years after birth, but these three are doing very well and have reached adult status. The others died over the period from 5 months of age to 20 months. All but one have been preserved.

In spite of the fact that *Crotalus s. scutulatus* and *Crotalus v. oreganus* are fairly easily distinguishable superficially by color and minor variation in marking, they appear to be rather closely related morphologically (Klauber, 1936, Trans. San Diego Soc. Nat. Hist., 8 (20): 185–276).

The major distinguishing features (Table I) of *C. v. oreganus* and *C. s. scutulatus* that I have used were taken from Klauber (*loc. cit.*). The mother of this litter conformed rather closely to the characters shown in the table for *C. s. scutulatus* except for having three scales between the supraoculars instead of the usual two. The male is not now available for comparison.

The most striking feature of the young was the anomaly in pattern (Plate I). Six of the twelve appeared to be normal *Crotalus s. scutulatus*, with the greenish color and the generally unicolored light scales comprising the blotch borders. Five of these are shown in Plate I: numbers one through four and number seven, counting from left to right. (The other snake is not shown since it had died previously.)

The five juveniles just mentioned lean towards the characteristics of *C. s. scutulatus* (Table I). Another animal, number nine in Plate I, also shows resemblance to *C. s. scutulatus* except for the posterior dorsal stripe and the mixed color of the light scales comprising blotch borders, features which are generally characteristic of numbers five, six, eight, and ten. Of these four, three show distinct pattern anomaly (numbers five, eight, and ten). These four, except for the pattern in three of them, look like *C. v. oreganus* and also show head scutellation characteristics more typical of this species. There is only one, number six, that shows all the characteristics of a normal *Crotalus v. oreganus*. The twelfth member of the litter that died shortly after birth bore a close resemblance to number six.

It thus appears that the characteristics of each individual hybrid tend either toward *Crotalus v. oreganus* or *Crotalus s. scutulatus*. The head scutellation tends toward that of *C. v. oreganus*; however the mother had slightly higher than average counts in this respect. It is unfortunate that the male is not now available for comparison.

The remarkable range in size exhibited by the 10 young snakes seems to be associated with their respective feeding habits. The smaller individuals, which generally resembled *Crotalus s. scutulatus*, ate only rarely during their first year of life, some indeed only once or twice. The larger individuals, which generally resembled *C. v. oreganus*, were

TABLE I

PARENTAL AND HYBRID CHARACTERS OF *Crotalus s. scutulatus* AND *Crotalus viridis oreganus*

Character	*Crotalus s. scutulatus*	Hybrids										*Crotalus v. oreganus*
		1	2	3	4	5	6	7	8	9	10	
Internasals	Usually 2	2	2	2	4†	4	4	2	4	2	4	Usually 3 or more
Scales anterior to supraoculars	6–11–21*	19	19	14	14	12	35	16	12	13	29	7–25–50*
Scales between supraoculars	1–2.1–5* (Usually 2)	4	5	3	3	6	7	4	5	5	6	2–5–9*
Line dividing the above groups of scales	Usually even and well defined (+)	+	−	+	+	+	−	+	−	+	−	Irregular and poorly defined (−)
Blotch color	Olive green (O-G)	O-G	O-G	O-G	O-G	D-B	D-B	O-G	D-B	O-G	D-B	Dark brown (D-B)
Light scales comprising blotch borders	Unicolor (+)	+	+−	+	Mostly +	−	−	Mostly +	−	−	−	Mixed color to conform with blotch shape (−)
Tail rings	Light rings wider (+)	−	−	−	−	−	−	−	−	−	−	Dark rings wider (−)
Pattern anomaly: present (+) Absent (−)	.....	−	−	−	−	+	−	−	+	+	+	.....

* Minimum, mean, maximum, respectively.

† Outside pair very much smaller than inner pair.

Ten of twelve hybrid rattlesnakes, between *Crotalus viridis oreganus* and *Crotalus scutulatus scutulatus*.

PHOTOGRAPH BY ARTHUR G. SHALK

voracious, having consumed an average of fully one mouse per week. The three that still survive are still eating voraciously. The eating behavior possibly reflects an individual difference in ability to adapt to the artificial conditions to which they are subjected. In this respect it is possible that *C. v. oreganus* surpasses *C. s. scutulatus*.

The aberrations in pattern here described were very noticeable and have led to considerable comment. It is quite likely that we have here a laboratory demonstration of some of the anomalies observed in the field where two closely related species of organisms occur in the same area, or where their ranges approach closely or overlap.

I wish to thank Dr. L. M. Klauber for his personal suggestions which were of great aid.—SHERBURNE F. COOK, JR., *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

A RECORD OF THE NORTHERN PINE-SNAKE, *PITUOPHIS MELANOLEUCUS MELANOLEUCUS*, FROM ALABAMA.—An adult female of *Pituophis melanoleucus melanoleucus* (Daudin) was collected by the author on June 5, 1953, 2 miles west of Leslie in the southeastern corner of Chilton County, Alabama, along a rural dirt road. The area is characteristic of the Upper Coastal Plain, with low hills, sandy soil, and an open forest association of *Pinus taeda* and *Quercus marilandica*.

The specimen is 49 inches in length, and has 220 ventral scales and 57 subcaudals. The dorsal scale count is 27–31–21; 8 upper labials and 13 lower labials are present. The ground color is white. There are 35 black dorsal blotches which are well defined on the posterior two-thirds of the body, and tend to become barely distinguishable anteriorly because of the increased pigmentation of the light interspaces. The ventral surface is immaculate on the anterior one-third of the body, with occasional small black spots irregularly distributed over the posterior two-thirds. These characters fall well within the limits characteristic of this subspecies (Stull, 1940, Bull. U. S. Nat. Mus., 175), apparently showing no intergradation with either *mugitus* or *lodingi*.

The specimen is the first to be recorded from Alabama, and constitutes an extension of its known range of distribution.—RALPH L. CHERMOCK, *Department of Biology, University of Alabama, University, Alabama.*

RANGE EXTENSION OF THE WHIPTAILED LIZARD *CNEMIDOPHORUS NEOMEXICANUS*.—According to Lowe and Zweifel (1952, Bull. Chi. Acad. Sci., 9 (13): 237), the range of the recently described whiptailed lizard, *Cnemidophorus neomexicanus*, extends from Bernalillo County to the southern boundary of White Sands National Monument, Otero County, New Mexico. Last year a collection was made which extends this range 60 miles south of its previous southern limit and into another state. On August 16, 1953, during a field trip conducted by the Student Department of the Oakland Public Museum, two specimens of *C. neomexicanus* were collected on the grounds of the Mesa Motel on U. S. Highway No. 80 in the northern outskirts of El Paso, Texas. Other lizards, believed to be of the same species, were observed in the immediate area, and a specimen of *C. tesselatus* was collected about a half mile away. The lizards were identified by Richard G. Zweifel, and they are now being kept in a collection owned by the Student Department.—JOHN F. LAWRENCE, *Student Department, Oakland Public Museum, Oakland, California.*

SYSTEMATIC STATUS OF THE KEY WEST SPADEFOOT TOAD, *SCAPHIOPUS HOLBROOKI ALBUS*.—The systematic status of *Scaphiopus holbrooki albus* Garman has been questioned for many years. Burt (1938, Trans. Kansas Acad. Sci., 41: 355), Carr (1940, Univ. Florida, Publ., Biol. Sci. Ser., 3: 53–4), and Wright and Wright (1949, Handbook of Frogs and Toads: 127–9) all regarded it as a doubtful form. During the course of a survey of the herpetofauna of southern Florida, it became necessary to examine the existing material and to try to reach some conclusion as to the status of the subspecies.

For collecting the specimens from the Miami area, I am indebted to L. Neil Bell and Albert Schwartz. I wish to thank Albert Schwartz for the loan of specimens from the Charleston Museum and John T. Wood for the loan of specimens from his personal collection. Unless otherwise noted the specimens mentioned are in the collections of the University of Michigan Museum of Zoology.

Specimens were examined from the following localities: GEORGIA—Glynn County: St. Simons Island. FLORIDA—Alachua County: Gainesville; Dade County: Miami and Surfside; Manatee County: Bradenton; Monroe County: Key West. SOUTH CAROLINA—Charleston County: 7.6 mi. SE of Charleston. VIRGINIA—James City County: vicinity of Williamsburg; York County: near Yorktown.

Garman (1877, Proc. Amer. Assoc. Advanc. Sci., 25: 194) stated that *Scaphiopus albus* (type locality, Key West, Florida) is characterized as being white with irregular bands of brown, and also (1884, Bull. Essex Instit., 16: 45) said that it is of smaller size than *Scaphiopus solitarius* (= *holbrooki*). Aside from the color differences, Wright and Wright (*op. cit.*: 129) suggested that the interorbital width is less in *S. albus* than in the

TABLE I

MEAN PROPORTIONS (±2 STANDARD ERRORS) IN MALES OF *Scaphiopus holbrooki* FROM FOUR LOCALITIES, INVOLVING TIBIA LENGTH (TL), DISTANCE FROM SNOUT TO VENT (S–V), INTERORBITAL WIDTH (IW), AND HEAD WIDTH (HW)

Locality	Number of specimens	TL/S–V	IW/S–V	IW/HW
Key West....	27	33.5±1.97	12.3±0.77	32.2±0.53
Miami.....	25	32.9±1.96	11.9±0.79	33.5±0.57
Surfside.....	22	33.2±0.40	12.4±1.12	33.3±0.77
Charleston...	21	32.9±2.05	12.2±0.68	32.9±0.74

typical subspecies. In the present study, coloration and certain structural characters were compared, and when large series of males were available the following measurements were taken: snout–vent length, tibia length, head width, and interorbital width. From these measurements three proportions were calculated: tibia length/snout–vent length, interorbital width/snout–vent length, and interorbital width/head width (Table I; Fig. 1).

The most obvious difference between the Key West and mainland specimens is in the overall size. Males from Key West average 51.7 mm. in snout–vent length, females 48.1 mm. Males from the Miami area average 59.2 mm. in snout–vent length, and those from Charleston 64 mm. Despite their small size, the individuals from Key West are sexually mature, since females 43 and 45 mm. in snout–vent length were gravid. However, gravid females 43 mm. in snout–vent length have also been found in the Miami area.

The dorsal color pattern of *Scaphiopus holbrooki* consists of three irregular, dark brown stripes on the back with light gray or tannish areas between them. Beginning as a Y on the head, the arms of the Y arising on the eyelids, the median dark stripe extends to the sacrum where it is interrupted by lighter color. The more lateral dark stripes begin just posterior to the orbit; they may continue posteriorly to the vent, or they may merge with the median stripe in the sacral region. The flanks are mottled with dark brown. Differences in coloration are brought about by variation in the width of the dark stripes and in the extent of the dark mottling. In most of the specimens from Key West the light ground color is more extensive than the dark mottling, and the light interspaces are wider than the stripes. Toward the north (in the coastal plain) there is a tendency for the dark color to become more extensive, thus reducing the light interspaces to narrow longitudinal lines; also, the ground color of the limbs and flanks tends to become confined to a much smaller area than the dark color. In specimens from farther north and from the west the light areas are still more reduced. However, the coloration upon which the subspecies *Scaphiopus holbrooki albus* was based does not hold up geographically. Many specimens from Key West show less light color than do those from Miami or even Charleston, and in a few individuals the dark color is more dominant than it is in the average spadefoot from Miami. A cotype of *S. h. albus*, U. S. Nat. Mus. No. 52403, agrees well with the specimens from Key West used here.

Since there are no significant structural differences between the spadefoot toads from Key West and those from the mainland, and since the colora-

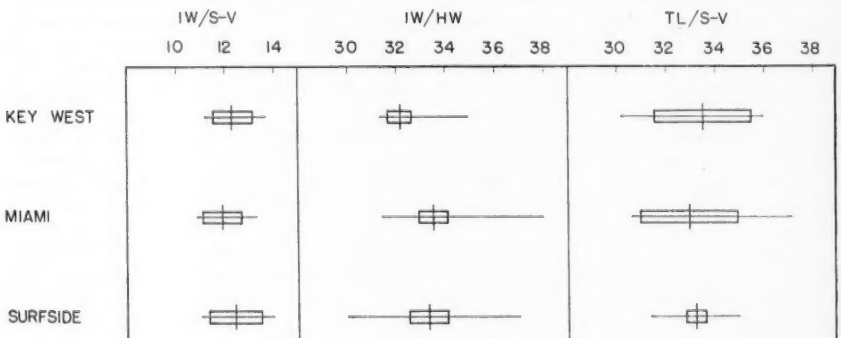

Fig. 1. Comparison of four series of *Scaphiopus holbrooki* with respect to three proportions involving interorbital width (IW), snout–vent length (S–V), head width (HW), and tibia length (TL). Vertical line = mean, horizontal line = range, box represents $\pm 2\sigma_{\bar{x}}$.

tion of the Key West population is not diagnostic, the name *Scaphiopus holbrooki albus* Garman should be relegated to the synonymy of *Scaphiopus holbrooki* (Harlan).—WILLIAM E. DUELLMAN, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

THE LIZARD *EUMECES ANTHRACINUS* IN CENTRAL VIRGINIA.—The coal skink, *Eumeces anthracinus* (Baird), was reported from the state of Virginia by Richard L. Hoffman (Proc. Biol. Soc. Washington, 57: 123–4). Mr. Hoffman collected three specimens in Alleghany County: one from Clifton Forge, and two from Middle Mountain. All three were collected from altitudes in excess of 1,000 feet. These are, apparently, the only published records of this species from Virginia.

On April 8, 1954, I collected an adult female of the coal skink on Pond Ridge, near the Charlottesville water reservoir in Sugar Hollow, Albemarle County, Virginia. The lizard was sunning itself in a bed of dried leaves beneath a rock ledge at an altitude of approximately 2,100 feet. The specimen, No. 844 in my private collection, measured (before preservation) 44 mm. snout-vent length, and 45 mm. tail length (partly regenerated). This record represents a range extension of approximately 70 miles east-northeast into Central Virginia.—SAM R. TELFORD, JR., *University of Virginia, Charlottesville, Virginia.*

A FURTHER RANGE EXTENSION OF *GYRINOPHILUS P. PORPHYRITICUS*.—The Tulane University collection contains a specimen (No. 4948) of *Gyrinophilus p. porphyriticus*. The data accompanying the specimen indicate that it was collected at Lock No. 14, Tuscaloosa, Alabama, in the spring of 1938. This locality is about 10 miles northeast of the center of Tuscaloosa, and extends the known range of the species about 50 miles farther southwestward. The specimen is about the same size and proportions as the one mentioned in a previous publication (Thurow, 1954, COPEIA, (3): 221) and both are similar to partly grown individuals in a New York series in the Tulane collection. I wish to thank Dr. Fred R. Cagle for allowing me to examine the material in this collection.—GORDON THUROW, *Zoology Department, Indiana University, Bloomington, Indiana.*

FALL AND WINTER FOOD OF *PLETHODON DORSALIS* IN JOHNSON COUNTY, INDIANA.—Because of the lack of food habit studies on *Plethodon dorsalis*, some recent data concerning this subject should be of interest. Hay (1892) collected a specimen of *Plethodon dorsalis* near Wyandotte Cave, Indiana, that had a small snail, allied to *Helix*, in its stomach, while another specimen contained the bodies of numerous ants. This appears to be the only reference in the literature regarding the food habits of this salamander.

TABLE I

FOOD ITEMS IN STOMACHS OF *Plethodon dorsalis*

Date	Air temp., F.	Number of specimens*	Stomach contents				
			Spiders	Larval and adult beetles	Red mites	Other arthropods	Slugs
10/12/52	75°	3 (0)	3	..	..	..	1
12/8/52	64°	2 (0)	1	1	..	1	..
1/14/53	60°	10 (5)	5	..	..	..	..
2/20/53	62°	8 (2)	4	3	1	1	1
Total....	..	23 (7)	13	4	1	2	2

* Number of specimens with empty stomachs given in parentheses.

In the course of a herpetological survey of Johnson County, Indiana, the stomachs of 23 specimens were examined over the fall and winter of 1952–53. The salamanders were all obtained within a few hundred feet of a small creek, 4 miles south of Trafalgar, in the southwestern part of the county. This area is the northern tip of the Knobstone Escarpment. Specimens were taken in both fall and winter under rotting leaves, logs and pieces of loose clay shale.

Four collecting trips were taken, two in the fall and two in the winter, to obtain the salamanders used for this study. On each of the four trips the temperature was at least 60°F. The sky on each trip was highly overcast and on two of them (January 14 and February 20) there was a heavy mist. All specimens examined were adults or subadults, the largest being 77 mm. (total length) and the smallest 49 mm. The specimens were preserved in formalin as soon as was possible, the longest time between capture and preservation being about 2 hours. The stomachs and their contents were examined under a dissecting microscope (Table I).

Eleven of the 18 stomachs examined during the winter contained food, indicating that this salamander feeds in this period, at least on warm days. All five of the stomachs examined in the fall contained food. The preponderance of spiders as food items is probably a reflection of the fact that they were numerous even during the colder winter days. In January, normally the coldest winter month, only spiders were found in the intestinal tract. *Plethodon dorsalis* has been observed feeding upon houseflies, fruitflies and ants in the laboratory, and thus it may be that the relative abundance of small invertebrates determines the proportion of each kind eaten.—J. ALAN HOLMAN, HN, *United States Naval Hospital, Memphis, Tennessee.*

Ichthyological Notes

COLOR VARIATION IN CERTAIN MARINE FISH EGGS.—Color problems in early developmental stages of fishes are two-fold. They include the study of colors of the egg yolk and of its oil globules and other included materials, and work on the colors of the pigment cells that develop during the embryonic and larval stages. This note concerns certain problems of the former type that have been encountered during recent studies on California marine fishes. I am indebted to Conrad Limbaugh of Scripps Institution for the opportunity to include mention of some of his observations on two of the species.

Gradual change in the color of the yolk or of the oil globule, or both, during embryonic development is well known. For example, the oil globule is pink in recently spawned eggs of a common west coast labrid, *Oxyjulis californica* (Günther), but it fades to colorless before the embryo hatches. Developmental color changes of this nature are usually correlated rather well with particular embryonic stages, hence they do not greatly complicate taxonomic description of the eggs. In some species, however, the original color of spawned eggs shows striking intraspecific variation, and eggs that differ in their original color may also undergo quite different sequences of developmental color changes. These factors make it difficult to define the normal range of color variation for purposes of identification and taxonomic study.

It is definitely known that in some species and under some conditions the eggs deposited at different times by the same individual may differ considerably in color. For example, Bolin (1941, Stanford Ichthy. Bull., 2 (3): 73–82) described color differences in eggs of a small marine cottid, *Orthonopias triacis* Starks and Mann, based on fertile eggs stripped at intervals over a total period of about one month from one gravid female. In this species the actual fertilization by the stored sperm apparently occurs as the eggs are extruded, for in each case development began after the eggs were removed. Most of the eggs obtained during the first few days were "colorless and fairly transparent. Most of the eggs stripped at later dates showed various tones of pale straw yellow and pinkish brown, a few being colorless, and eggs of various colors occurring in the same batch." There was no indication that any of these egg colors denoted abnormality, for healthy larvae were hatched from all groups of eggs. The diet of the adult fish during captivity was not mentioned.

The eggs of the tubenose, *Aulorhynchus flavidum* Gill (Aulorhynchidae), are deposited in small clusters. I have studied the development of this fish in detail, and find that the eggs within a particular cluster are uniformly of the same color, and there is an obvious but rather limited range of color variation between different egg masses. Recently-spawned eggs vary from pale honey-tan through various shades of brownish-orange to dark reddish-amber. The eggs of each color become progressively paler as development proceeds, and at hatching the small yolksac is pale yellowish or slightly greenish-yellow. Eggs from the full range of color variation produce normal embryos. Nothing is known of the factors that regulate these color differences in *Aulorhynchus*.

Examples of more sharply contrasted intraspecific variation in egg color have been encountered, and two of the species offer particularly interesting color problems. Barnhart (1932, Bull. Scripps Inst. Oceanog., Tech. Ser., 3: 87–99) reported a mass of aquarium-spawned eggs of the kelpfish, *Heterostichus rostratus* Girard (Clinidae), to have "light purple" yolk and "reddish brown" oil globules. More recent work at Scripps Institution has shown that recently-spawned egg masses of *Heterostichus* may have either of two strikingly different colors: the yolk may be purple and the oil globule orange, or both the yolk and the oil globule may be pale yellow. During the course of development the purple eggs gradually fade to pinkish or grayish lavender. Eggs of both types produce normal embryos, and so far as known all of the eggs that are spawned together by the same female are uniformly of the same color. Both types of eggs have been deposited in aquaria at Scripps Institution, both have been taken locally, and Conrad Limbaugh has collected the purple type at Newport, California. The wide extremes in egg color in this species offer some desirable experimental problems. It would be especially interesting to learn whether the egg color is determined by dietary factors and whether it is correlated in any way with the reversible color phases for which the adult stage of *Heterostichus* is noted.

One of the well-known sport fishes of the Pacific coast is a giant cottid, the cabezon, *Scorpaenichthys marmoratus* (Ayres). In this species there are some puzzling problems in color phases both in the eggs and in the adult stage. Barnhart (*op. cit.*) briefly discussed a mass of greenish eggs laid by *Scorpaenichthys* in a tank at Scripps Institution. In a recent study of the life history of the cabezon in northern California, O'Connell (1953, Calif. Dept. Fish and Game, Fish Bull. No. 93) described the eggs as uniformly amber-colored, though he recorded only three females that contained fully mature ovaries. Egg masses spawned in the aquarium at Scripps Institution, and eggs collected by Conrad Limbaugh during aqualung diving studies, indicate that

in the La Jolla area the eggs of *Scorpaenichthys* occur in at least three color phases. The yolk colors most commonly observed are pink and green. The former gives the egg mass a somewhat purplish-amber macroscopic appearance, but the yolk is pink under magnification, and the green color is essentially like the peculiar blue-green or turquoise tone of the green adults. In one sample seen thus far, the yolk was colorless. The pink and green eggs become somewhat paler during incubation, but their basic color is clearly apparent throughout development. Larvae have been hatched from eggs of the pink and green types, and the colorless eggs were retained alive until they reached advanced embryonic stages. It seems probable that the eggs laid by a female at one spawning are all of the same color, but it would be difficult to be certain of this in all cases because of the habit of the male *Scorpaenichthys* of accumulating and guarding multiple masses of eggs that obviously represent several different spawning periods, probably by different females. The colorless eggs collected by Limbaugh were taken from such a multiple mass which contained superimposed clumps of eggs of each of the three known color phases, each in a different embryonic stage.

O'Connell (*op. cit.*) reported evidence of sexual dimorphism in the background color of the cabezon in the vicinity of Monterey, California. The majority of the immatures of each sex were red, 92 percent of the 37 mature males were red, and 97 percent of the 64 mature females were green. The pattern background of a few specimens was recorded as white. These were chiefly small individuals or fish showing the seasonal fading of background color that he noted to occur in non-breeding adults of both sexes. The maximum size group included two males and one female recorded as "white."

Preliminary evidence thus suggests that in the Monterey area the background color of the adult cabezon is usually red (most mature males) or green (most mature females), but occasionally white (rare in breeding adults?); and in the La Jolla area the spawned eggs are usually pink or green, rarely colorless. Much more information is needed on all developmental stages of this species in order to determine the factors that govern the color variability, whether these factors are uniform throughout the range, and whether the color of the eggs is predictably correlated with the color of the female. Do fishes of a "white" color phase (colorless background) spawn the colorless eggs? The chemical nature of the red and green pigments of this fish is not yet clear (see O'Connell).

Variations in the color characteristics of fish eggs offer interesting opportunities for study along the borderline of systematics and biochemistry. Problems in the regulation of egg color by dietary factors or other biochemical controls, especially in marine fishes, warrant much more extensive study (see discussion in Fox, 1953, *Animal Biochromes and Structural Colours*, Cambridge Univ. Press). The fields of biochemistry, physiology, and embryology are among the less-explored sources of data for systematics, but they should be watched more closely for new discoveries in fundamental processes of function and development that may help to widen our understanding of the bases of taxonomic characters.—GRACE L. ORTON, *Scripps Institution of Oceanography, University of California, La Jolla, California.*

THE RIBBED SCULPIN, *TRIGLOPS NYBELINI*, IN SPITSBERGEN WATERS.—Jensen (1944, Skrift. Univ. Zool. Mus. København, 4: 7–30) recognized two kinds of North Atlantic cottids belonging to the genus *Triglops*: *T. pingeli* and an undescribed species which he named *T. nybelini*. The range of the latter was given as east and west Greenland and Jan Mayen. *Triglops nybelini* has since been reported from northern Labrador by Backus (1951, COPEIA (4): 293) and from Ungava Bay by Dunbar and Hildebrand (1952, Jour. Fish. Res. Bd. Canada, 9: 113–5). Through the kindness of Mr. Ralph Friedman of New York, the American Museum of Natural History (AMNH) received a collection of fishes from Spitsbergen, the Barents Sea, and northern Norway; Dr. H. M.-K. Lund of the Tromsø Natural History Museum obligingly devoted time and effort to making the collection. Included in this collection are nine specimens of *T. nybelini* from Spitsbergen, evidently the first record for this species in European waters. The data for these fishes are as follows: Forlands-sund (Spitsbergen) at 78°15.5′ N, 12°29.5′ E; September 10, 1953; depth 200 meters; bottom temperature 2° C.

The Spitsbergen fishes (AMNH No. 20118) consist of four females 90–103 mm. in standard length and five males 71–82 mm. long. All show the diagnostic features of the species: (1) eye diameter exceeds distance from rear of orbit to dorsal terminus of gill opening (equal in *T. pingeli*); (2) suborbital width much less than maxillary height (about equal in *T. pingeli*); (3) middle pelvic ray longest (innermost pelvic ray longest in *T. pingeli*); and (4) pectoral rays 20–22 (16–19, seldom 20 in *T. pingeli*, while seldom 19 in *T. nybelini*).

Dunbar and Hildebrand considered *T. pingeli* to have dark saddles across the dorsum, which are absent in *T. nybelini*. Some of the Spitsbergen *T. nybelini* have ill-defined saddles and both of Jensen's figures of the lateral aspect of the species indicate faint saddles; in addition Jensen noted that saddles may be faint or some may be absent in *T. pingeli*. Thus presence or absence of saddles is not a reliable distinguishing character. Dunbar and Hildebrand

also regarded *T. nybelini* to be characterized by having longitudinal dark bars on the sides below the lateral line. Jensen noted that these dark bars may be present in *T. pingeli*. Longitudinal barring cannot be considered a diagnostic character.

Spitsbergen *T. nybelini* have a completely dark peritoneum and Dunbar and Hildebrand's postlarva had a very dark peritoneum. In adult *T. pingeli* examined by the writer the peritoneum is dark-colored only in its dorsal portion. Jensen did not mention peritoneum color for either species; thus we cannot yet conclude that the color differences are diagnostic.

The available data do not indicate any marked differences between the species with regard to thermal preferences, though *T. pingeli* seemingly tolerates colder water than does its generally more northerly relative. Labrador *T. pingeli* were reported by Backus (1953, The Marine and Freshwater Fishes of Labrador, Cornell University doctoral thesis) from −1.68° to 2.52° C. Jensen gave the thermal range for Greenland *T. nybelini* as −0.42° to 1.06°, and the current Spitsbergen fishes were taken at 2° C.

There seems to be no marked difference between the species as to vertical range, though *T. pingeli* tends to be more common in shallower water. Other than Dunbar and Hildebrand's Ungava Bay postlarva, which was taken in mid-water at about 30 meters' depth, *T. nybelini* has not been collected thus far in water shallower than 150 meters and has been taken down to 930 meters. On the other hand, Jensen stated that *T. pingeli* is fairly common in Greenland down to 285 meters and one was taken at 930 meters, together with 22 *T. nybelini*.—VLADIMIR WALTERS, *2836 Decatur Avenue, New York 58, N. Y.*

SNAKE-EELS AS PSEUDOPARASITES OF FISHES.—Several reports of snake-eels (Ophichthidae) found as pseudoparasites in other fishes have appeared in the literature; where detailed accounts have been given, the eels were reported from the coelomic cavity. After describing *Pisoodonophis cruentifer* (syn. *Omochelys cruentifer*), Goode and Bean (1895, U. S. Nat. Mus. Spec. Bull. No. 2: 147) reported that specimens had been taken from the bodies of fishes (unidentified) and shriveled remains of an apparently closely related species were sometimes found in salted halibut and codfish. The authors did not state where in the body the eels were found. Deraniyagala (1932, Spolia Zeylanica, sec. B, vol. 16: 355–6) identified *Ophichthus apicalis* from the body cavities of various percoids. Breder and Nigrelli, (1934, COPEIA (4): 162–4) reported a large *Myrichthys acuminatus* from the coelom of a jewfish, *Promicrops itaiara*. Breder (1953, Zoologica; 38: 201–2) identified as *Omochelys cruentifer* a specimen found in the coelom of a sea bass, evidently *Centropristis striatus*. As in the present case, the previous reports concerned hard and shriveled eels which may be considered "mummies".

Suvorov (1948, Osnovy ikhtiologii; 2nd ed., augmented, pp. 312, 512; Leningrad) related that the angler, *Lophius piscatorius*, is sometimes *parasitized* by the eels *Ophichthys* and *Apterichthys*; the eels were not identified to species. More will be said of Suvorov's claim.

While examining a "Golden Grouper" (*Alphestes* sp. indet.), a mummified eel was found in the coelomic cavity. The grouper, 760 mm. in standard length, had been caught by personnel of the Lerner Marine Laboratory on December 29, 1951, at a depth of 1300 feet, west of Bimini, Bahamas, B.W.I. The eel was "encysted" in a mesentery near the grouper's right ovary but originally it may have been closer to the grouper's stomach. The *Alphestes* had been brought from 1300 feet to the surface in about 4 minutes (a decrease in pressure to about $\frac{1}{40}$ of the original value), and the gases liberated by the explosion of the swimbladder had so permeated the mesenteries that the coelom had a frothy appearance when the fish was opened for study. Some of the internal structures may have shifted as a result of the explosion. In addition the eel was not found until after the writer had probed about in the coelom for some time, making it impossible to search for scar tissue marking the point of entry of the eel into the coelom.

The "mummy", preserved at the American Museum of Natural History (AMNH No. 19902), is about 230 mm. long; it cannot be measured more precisely owing to its contorted shape. The absence of a caudal fin places the eel in the Ophichthidae. The absence of molariform teeth, the presence of dorsal, anal, and large pectoral fins, and the origin of the dorsal fin behind the gill opening identify it as a species of *Ophichthus*. The uniserial vomerine dentition, biserial dentition of the upper and lower jaws, the absence of pronounced canines, the dorsal fin origin anterior to the tip of the pectoral fin, and the tail somewhat longer than the rest of the body, in addition to the locality at which the grouper was captured, indicate that the eel is *Ophichthus ocellatus* (LeSueur).

Although the eel's body was shriveled and hardened, the connective tissue "cyst" laid down around it by the grouper was thin and whitish, there being few melanophores visible. The "cyst" was stripped off the eel to facilitate identification. The tissue came off as readily as taking off a rubber glove. It is possible that the eel's carcass had been in the grouper's coelom only a short while before the fish was caught.

In addition to the mummified eel the grouper's mesenteries contained numerous iridescent, black,

hard capsules of irregular shape that varied in length from about 4 mm. to almost 50 mm. Similar objects were found by the writer in Bimini specimens of *Epinephelus mystacinus*. Upon opening these capsules, an amorphous mass of pale-colored material was found to occupy some of the space. These capsules are apparently similar to the hard, black objects reported by Breder and Nigrelli from *Promicrops itaiara*. Breder and Nigrelli suggested these objects may be "cysts" laid down by the fish over foreign but not parasitic bodies. Their identity remains unsolved, but perhaps they may be associated with materials which enter the coelomic cavity when the body wall is pierced accidentally while the fish is feeding.

The exact mode of entry of ophichthids into the coelomic cavity is not known. The writer favors the explanation offered by Breder and Nigrelli and by Breder, i.e., the engulfed eel in its struggles to escape plunges its sharp tail through the gut wall of the fish and wriggles backward through the opening, dying in the coelom soon thereafter. Breder and Nigrelli effectively disposed of Deraniyagala's commensalism hypothesis. Suvorov related that snake-eels sometimes parasitize *Lophius* but did not cite the source for this statement, did not say where in the fish the eels are found, and did not mention whether or not the eels are shriveled and "encysted". Goode and Bean suggested that *Pisoodonophis cruentifer* may be a parasitic borer, but knowledge of snake-eel behavior and anatomy does not support this view (Breder); the authors evidently thought their fish has the same habits as *Simenchelys parasiticus* which is a true parasite. There is no evidence that snake-eels can survive in the body of a fish, which is a prime requisite for parasitism.

All of the fishes found with ophichthids in the coelomic cavity are predators that feed on or near the bottom. It is expected that a great variety of bottom-feeding predators will be found to harbor ophichthid "mummies" and that the identities of the "mummies" will depend upon the snake-eel fauna of the particular area.—VLADIMIR WALTERS, *2836 Decatur Avenue, New York 58, N. Y.*

MELAMPHAES TRICERATOPS, A SYNONYM OF THE DEEP-SEA FISH *M. ANTHRAX*.—A specimen of the genus *Melamphaes* taken by the U. S. Fish and Wildlife Research Vessel OREGON in the Gulf of Mexico is identified as the species currently called *Melamphaes triceratops* Roule and Angel. That species, however, appears to be a synonym of a fish described by Osório in 1906 as a new genus and species, *Lophocephalus anthrax*.

Lophocephalus was shown by Norman (1929) and by Coelho (1942) to be a synonym of *Melamphaes* Günther. *M. anthrax* has been overlooked by many subsequent authors. The principal difference between the description of *triceratops* and that of *anthrax* is the notably larger eye of the latter species. However, Coelho found the eye to be about 7 in the length of the head, proportionately similar to that of *triceratops*, in the four specimens examined by him (part of the Carlos de Bragança collection), and noted further that the figure of the type of *anthrax* (published by Osório) shows the eye to be about one-seventh of the head length. He therefore concluded that Osório's statement "eye 5.5 in head" must have been an error. The two forms are compared in the accompanying table.

TABLE I

COUNTS AND PROPORTIONS FROM PUBLISHED ACCOUNTS OF *Melamphaes anthrax* AND *M. triceratops*

Species Authority	Dorsal rays	Anal rays	Depth in		Head in		Eye in head
			Tot. length	Stand. length	Tot. length	Stand. length	
M. anthrax							
Osório	III 11	I 8	4.5+	...	3.0	...	7.0±*
M. triceratops							
Roule & Angel	III 10	I 8	...	3.6	...	2.6	6
Parr	III 10–11	10–11	...	ca. 3.5	...	2.25–2.6	ca. 6.5
Pellegrin	III 11	I 8	...	...	...	...	7
Koefoed	III 10–11	I 8–9	...	3.33–3.66	...	2.25–2.66	6.5–8.0

* Fide Coelho.

Unfortunately Osório failed to include the standard length and many proportions in his description of *anthrax*; nor did he state the number of scales between nape and caudal. However, the species is quite distinct from others of the genus *Melamphaes* in the spinous development of the head, and this character, as well as the positions of the fins and the greatly enlarged scale on the opercle, easily identifies *triceratops* with *anthrax*.

M. anthrax has been reported from off the coast of Portugal, the type locality, at depths of 750 to 1700 meters; in the Gulf of Gascony at 30 meters; west of the Canary Islands in 0–3000. meters; northwest of Madeira in 0–3500 meters; in the central north Atlantic (31°40° N. Lat., 35°–50° W. Long.) in 0–2000 and 0–3000 meters; east of Nova Scotia (ca. 43°N., 59°W.) in 0–2500 meters; and near Bermuda in about 900–2000 meters. To these records may be added one specimen, 83 mm. long, taken by the OREGON on June 10, 1953, at Station 841, 28°58′N., 88°00′W., northern Gulf of Mexico, at a depth of 1518–1700 meters, and three examples 42–65 mm. long caught off Bermuda in July and August, 1948, in about 275, 730 and 1100 meters. Recorded depths are not necessarily those at which

the specimens were actually caught as species of the genus *Melamphaes* are probably all bathypelagic. A few of the thirty-eight specimens known were taken on lines, one in 750, one in 1700, and another in 30 meters. Recorded lengths range from 43 (37 mm. standard length) to 115 mm. total length.

Melamphaes anthrax (Osório)

Plectromus cristiceps Bragança 1903,* Cat. Coll. Exp. Pal. Crist. Port., p. 39 (not of Gilbert, 1890, Proc. U. S. Nat. Mus., 13: 60).
Lophocephalus anthrax Osório 1906, Jorn. Sci. Math. Phys. Nat., 7: 172, fig.; 1909, Mem. Mus. Bocage, 1: 8, pl. 1, fig. 1; Seabra 1911*, Bull. Soc. Portugal Sci. Nat., 5: 140; Norman 1929, Ann. Mag. Nat. Hist., (10) 4: 159; Nobre 1935, Faun. Mar. Portugal, 1: 5, pl. 1, fig. 2.
Melamphaes triceratops Roule and Angel 1933, Res. Camp. Sci. Monaco, 86: 66, pl. 3, fig. 32; Parr 1933, Bull. Bingham Oceanogr. Coll., 3 (6): 15, 21, fig. 9; Pellegrin 1934, Bull. Soc. Zool. France, 59: 266; 1937, Bull. Mus. Hist. Nat. Paris, 9: 369; Fowler 1936, Bull. Amer. Mus. Nat. Hist., 70: 1264, fig. 542; Koefoed 1953, Rep. Sci. Res. M. Sars No. Atl. Deepsea Exp. 1910, 4, pt. 2, no. 3: 30, pl. 4, fig. B.
Melamphaes anthrax Coelho 1942, Trav. Stat. Biol. Mar. Lisbonne, 46: 45.
Melamphaes cristiceps (part) Lozano Rey 1952, Mem. R. Acad. Sci. Madrid, 14: 42.

—MARION GREY, *Chicago Natural History Museum, Chicago 5, Illinois.*

OCCURRENCE OF THE LANCET FISH, *ALEPISAURUS FEROX*, IN THE GULF OF MEXICO.—The introduction of new types of commercial fishing gear into an area often provides valuable material for the study of fish distribution and abundance. The trials of tuna long-line gear being conducted by the U. S. Fish and Wildlife Service in the Gulf of Mexico are no exception; in addition to the more valuable scombroid and elasmobranch fishes, the first Gulf trials of this line produced twelve adult specimens of the lancet fish, *Alepisaurus ferox* Lowe (1833, Proc. Zool. Soc. London, 1833: 104). These specimens are the first collected in the Gulf of Mexico, and their capture aids in determining the bathymetric and geographical range normal to this species.

The specimens were taken during the twenty-third cruise of the M. V. OREGON, the research vessel operated from Pascagoula, Mississippi, by the Branch of Commercial Fisheries, U. S. Fish and Wildlife Service. The long-line, comparable in design to the Japanese-type line operated in the Pacific by the Pacific Oceanic Fishery Investigations (Niska, 1953, Comm. Fish Rev., 15 (6): 1–6), was set daily at 7:00 AM and hauled at about 10:00 AM. Hooks were placed at depths varying from 5 to 35 fathoms. *Alepisaurus ferox* was taken at the following six widely spaced stations, of the twenty long-line stations occupied during May and early June in the western Gulf of Mexico:

OREGON station number	Date (1954)	Latitude (North)	Longitude (West)	Surface temperature (F)	Number of specimens
1045	May 12	23° 10′	92° 00′	78°	2
1053	May 15	20° 00′	92° 25′	78°	2
1065	May 21	20° 34′	95° 37′	78°	5
1071	May 24	22° 33′	97° 04′	78°	1
1073	May 25	23° 12′	97° 02′	78°	1
1079	May 28	26° 15′	95° 30′	77°	1

The fish, varying in fork length from 456 to 1362 mm., include both males and females. The gonads were in a resting condition.

Pending evidence to the contrary, it seems best to include both *Alepisaurus altivelis* Poey (1861, Mem. Hist. Nat. Cuba, 2: 302, pl. 18) and *A. poeyi* Gill (1863, Proc. Acad. Nat. Sci. Philadelphia, 14, (1862): 131) in the synonymy of *A. ferox*. The examination of the highly variable material now available does not demonstrate the existence of more than a single western Atlantic population of *Alepisaurus*.

The various nominal forms of *Alepisaurus* appear to be nearly cosmopolitan in distribution. A review of some of the published reports of this fish from the northern oceans shows that *A. ferox* has slight regard for the temperature of the waters in which it swims. It has been reported from Iceland (Saemundsson, 1949, Marine Pisces, *in* The Zoology of Iceland, 4 (72): 102); Greenland (Jensen, 1948, Spolia Zoologica Mus. Hauiensis, 9: 114); Portugal (Nobre, 1935, Fauna Marinha de Portugal – Peixes de Portugal: 402; and others); Madeira (type; many subsequent records, e.g. Maul, 1946, Bol. Mus. Municipal do Funchal, 2 (2): 53–4; Vaillant, *in* Roule, 1919, Res. Camp. Sci., Monaco, 52: 130; review of records in Fowler, 1936, Bull. Amer. Mus. Nat. Hist., 70 (1): 412; and others); the Canary Islands (Vinciguerra, 1892, Atti Soc. Ital. Sci. Nat., 34: 330); Bermuda (Beebe, 1937, Zoologica, 22 (3): 205); the Nova Scotia and New England Banks (Goode and Bean, 1895, Oceanic Ichthyology: 117–8; Bigelow and Schroeder, 1954, U. S. Fish and Wildlife Serv., Fish. Bull. 74 (1953): 161; Vladykov and McKenzie, 1935, Proc. Nova Scotian Inst. Sci., 19: 63); North Carolina (Brimley, 1938, Jour. Elisha Mitchell Sci. Soc., 54: 245); and Cuba (*A. altivelis* Poey; *A. poeyi* Gill, (*loc. cit.*). I have recently been informed by Mr. Frank Stick of Kitty Hawk, North Carolina, that two additional North Carolina specimens were taken in 1950. Both were caught in commercial nets set close to shore at a depth of less than four fathoms.

Although many authors refer this species to the

* Starred references not seen by author.

bathypelagic fauna because of its bizarre appearance and poorly ossified skeleton, the authoritative records currently available indicate a broad bathymetric distribution. Many of the early reports were of dead or dying fish which were found near the shore or of individuals purchased at fish markets, poor material for the study of depth distribution. Specimens reported by Goode and Bean (*loc. cit.*) were taken from depths ranging from the surface to 275 fathoms. On the basis of 122 specimens caught during his intensive midwater trawling south of Bermuda, Beebe (*loc. cit.*) found the vertical range of his specimens of *Alepisaurus ferox* to lie between 500 and 1000 fathoms. Specimens reported from Madeira (see citations above) were taken from depths greater than 100 fathoms. Types of the Cuban species described by Gill and by Poey were said to have been taken in deep water. Several other reports note the presence of *Alepisaurus* near the surface. Among these are the accounts of Jensen (*loc. cit.*), and, in the Pacific, those of Murphy and Shomura (1953, U. S. Fish and Wildlife Service, Spec. Sci. Rept.–Fish., 108), the Pacific Oceanic Fishery Investigations (Anon., 1954, Comm. Fish Rev., 16 (5): 33) and several northeastern Pacific records (Kendall, 1922, Copeia, no. 103: 17; Crawford, 1927, *ibid.*, no. 160: 182; Crawford, 1929, *ibid.*, no. 171: 39; Cowan, 1938, *ibid.*, (2): 97.). It is also caught occasionally in the surface gill nets operated by the Japanese salmon fishermen off the coast of Kamchatka.

It this appears that the occurrence of *Alepisaurus ferox* in the surface waters of the Gulf of Mexico is not an unexpected finding. This does, however, emphasize the wide latitudinal and bathymetric limits within which *A. ferox* occurs and the lack of correlation between the depth and latitude at which it has been captured.—Giles W. Mead, *U. S. Fish and Wildlife Service, Woods Hole, Massachusetts.*

FIRST RECORD OF THE MULLET *MUGIL LIZA* FROM FLORIDA.—On December 6, 1952, in the course of routine examination of catches of black or striped mullet (*Mugil cephalus*), the writer found one specimen of the Caribbean and West Indies species, *Mugil liza* (Cuvier and Valenciennes), among several hundred *M. cephalus* Linnaeus caught by Mr. Carleton Forrest at Salerno, southeastern Florida. This catch had just been brought from the fishing grounds to be packed for shipment. It may be assumed, therefore, that the specimen was caught in the immediate area. Many thousands of striped mullets have been examined throughout the state since the Marine Laboratory of the University of Miami began research on mullet for the Florida State Board of Conservation in 1949, but no other specimen of *M. liza* has been noticed. This specimen is in the museum of the University of Miami, Cat. No. 1016.

In 1949, Professor Luis René Rivas stated in a mimeographed "Key to the Florida and Gulf of Mexico Fishes of the Genus Mugil (Mullets)," that a hitherto unrecorded species might occur in Florida waters. *Mugil liza* (see Jordan and Evermann, 1896, *The Fishes of North and Middle America*, pp. 806–16; equals *Mugil brasiliensis* of authors, not of Agassiz *in* Spix, 1829, *Pisces Brazil*, p. 234, plate 72) was tentatively included with the statement, "It [is] . . . not definitely reported as yet, but probably [occurs] in south Florida." Later in the same year Rivas included this species name in his "Check List of the Florida Game and Commerical Marine Fishes," (1949, Marine Lab., Univ. Miami, Educational Ser. No. 4.).

Since the first local observation of *M. liza*, the species has been described to commercial fishermen in nearly all parts of Florida. Mr. Bill Hughes, a seafood dealer in Everglades City, stated that fishermen catch what is known locally as "Mexican mullet" and that this fish resembles the description of *M. liza*. It is hoped that specimens will be secured during the fall when they are said to appear in the commercial catch.

The writer is grateful to Professor Rivas for confirming the identification of the specimen. This paper constitutes Contribution No. 135 of the Marine Laboratory, University of Miami.—H. P. Mefford, *Marine Laboratory, University of Miami, Coral Gables, Florida.*

EGG PRODUCTION OF THE FISH *HADROPTERUS SCIERUS APRISTIS* IN SAN MARCOS RIVER, TEXAS.—On June 4, 1952, seven Guadalupe dusky darters, *Hadropterus scierus apristis* Hubbs and Hubbs in Clark Hubbs, 1954, Amer. Midl. Nat., 52 (1): 211–3), were collected from the San Marcos River below the wooden bridge at Thompson Island, one-half mile southeast of San Marcos, Texas. The river at the collection site was swift and clear, as it is at all times of the year. It flows over gravel with stubby growths of *Vallisneria* in scattered patches. The water was 6 to 24 inches deep and had a temperature of 23° C. and a pH of 7.8. The darters were in breeding coloration and one female was particularly large with eggs. The actual egg count from this female, which measured 66 mm. standard length and 73 mm. total length, was 443 eggs. The heavy, adhesive eggs were firm, large, and uniform in size (approximately 1.5 mm.). A second female, 65 mm. in standard length and 76 mm. total length, was found to contain 656 eggs by actual count. The eggs were not so far advanced as in the first female and were diversified in size (approximately 0.5 to 1.5 mm.). Two other females examined contained eggs in a developmental

stage similar to the latter fish. The remaining three darters taken were males in breeding coloration. Specimens of this subspecies taken by Reeve M. Bailey at the same site, during the field trip of the American Society of Ichthyologists and Herpetologists on April 12, 1952, were also in breeding coloration and the females flowed eggs when slight pressure was applied. Since the water temperature at the collection site varies only about 3° C. throughout the year (22° to 25° C.), it appears that the Guadalupe dusky darter has a rather prolonged breeding period in its type locality, the headwaters of the San Marcos River. Future collections made throughout the year are needed to define this breeding period as well as the period of major spawning activity.—WILLIAM H. BROWN, *State Fish Hatchery Laboratory, San Marcos, Texas.*

NOTES ON THE CAPTURE OF YOUNG SAILFISH AND SWORDFISH IN THE GULF OF MEXICO.—Although the broadbill swordfish, *Xiphias gladius* Linnaeus, and the sailfishes, *Istiophorus* sp., are found throughout the warm waters of the world and are much sought-after game fishes, surprisingly little is known concerning their life histories. The following capture records of pre-adult forms taken in the Gulf of Mexico are presented as a contribution to our knowledge of these species.

Early stages of the swordfish are identified readily by referring to a series of excellent papers by Sanzo on the larval forms of this species. Identification of sailfish larvae poses a more difficult problem. As Voss pointed out in his recent paper on sailfish (1953, Bull. Mar. Sci. Gulf and Carib., 3 (3): 206–40), the very young of marlin and spearfish have never been taken to be recognized as such, and extreme care must be exercised to avoid possible confusion. With this possibility in mind, each specimen included in this presentation was compared and checked carefully with texts and figures in available publications on sailfish. Through the courtesy of Jack W. Gehringer, U. S. Fish and Wildlife Service, whose paper on the development of sailfish is now in preparation, they were compared and checked further with known sailfish specimens of similar sizes.

Plankton and dip-net collections made during field work aboard the M/V ALASKA and M/V OREGON, research vessels of the U. S. Fish and Wildlife Service, yielded fifteen larval and one juvenile sailfish, *Istiophorus americanus* (Cuvier), and thirty-two larval swordfish. The term "juvenile" refers to specimens in which metamorphosis into the general adult form has occurred, although several larval characteristics still may be evident. According to available literature, the ALASKA specimens, taken over the period from April 29, 1951, to June 19, 1953, were the first of the very young of these species to be captured in the Gulf of Mexico.

TABLE I

CAPTURE RECORDS FOR YOUNG SAILFISH AND SWORDFISH

Under "gear", SN = ½-meter silk net, Di = dipnet, MN = metal net

Species	S. L., mm.	Date	Time	Gear	Locality	
					N. Lat. °_′	W. Long. °_′
Sailfish	4.8	4/29/51	0900	SN	23–11	82–24
Sailfish	6.0	8/15/51	1400	SN	26–09	83–50
Sailfish	4.0	8/15/51	1400	SN	26–09	83–50
Swordfish	26.9	5/25/52	1012	Di	27–18	87–30
Swordfish	55.4	5/30/52	0015	Di	26–00	85–15
Sailfish	64.1	5/30/52	0015	Di	26–00	85–15
Swordfish	8.2	6/2/52	0600	MN	27–40	85–05
Swordfish	19.8	2/25/53	1030	MN	25–06	87–30
Sailfish	5.3	6/8/53	1945	MN	26–09	86–34
Sailfish	4.3	6/8/53	1945	MN	26–09	86–34
Sailfish	3.8	6/8/53	1945	MN	26–09	86–34
Sailfish	3.6	6/8/53	1945	MN	26–09	86–34
Swordfish	6.1	6/9/53	0500	MN	27–00	87–30
Sailfish	8.6	6/10/53	2100	MN	27–55	93–38
Sailfish	7.3	6/10/53	2100	MN	27–55	93–38
Sailfish	7.2	6/10/53	2100	MN	27–55	93–38
Sailfish	6.4	6/10/53	2100	MN	27–55	93–38
Sailfish	6.2	6/10/53	2100	MN	27–55	93–38
Sailfish	6.1	6/10/53	2100	MN	27–55	93–38
Sailfish	5.3	6/10/53	2100	MN	27–55	93–38
Sailfish	20–65	8/10 to 9/2/53	...	Di	...†	...†
Swordfish	79.5	5/8/54	Night	Di	26–40	92–00
Swordfish	49.1	5/8/54	Night	Di	26–40	92–00
Swordfish	51.5	5/10/54	Night	Di	24–22	92–00
Swordfish	34.2	5/10/54	Night	Di	24–22	92–00
Swordfish	47.0	5/21/54	Night	Di	20–25	95–45
Swordfish	28.0	5/22/54	Night	Di	21–42	95–35
Swordfish	47.0	5/23/54	Night	Di	22–10	96–20
Swordfish	43.2	5/23/54	Night	Di	22–10	96–20
Swordfish	42.9	5/23/54	Night	Di	22–10	96–20
Swordfish	42.5	5/23/54	Night	Di	22–10	96–20
Swordfish	38.2	5/23/54	Night	Di	22–10	96–20
Swordfish	28.5	5/23/54	Night	Di	22–10	96–20
Swordfish	51.0	5/24/54	Night	Di	22–30	96–57
Swordfish	50.5	5/24/54	Night	Di	22–30	96–57
Swordfish	50.0±*	5/24/54	Night	Di	22–30	96–57
Swordfish	39.5	5/24/54	Night	Di	22–30	96–57
Swordfish	39.0	5/24/54	Night	Di	22–30	96–57
Swordfish	37.3	5/24/54	Night	Di	22–30	96–57
Swordfish	35.0	5/24/54	Night	Di	22–30	96–57
Swordfish	32.5	5/24/54	Night	Di	22–30	96–57
Swordfish	32.5	5/24/54	Night	Di	22–30	96–57
Swordfish	49.5	5/26/54	Night	Di	24–00	96–50
Swordfish	20.2	5/26/54	Night	Di	24–00	96–50
Sailfish	...*	5/26/54	1400	MN	24–30	96–39
Swordfish	43.5	5/27/54	Night	Di	24–54	96–05
Swordfish	38.5	5/27/54	Night	Di	24–54	96–05
Swordfish	32.5	5/27/54	Night	Di	24–54	96–05
Swordfish	?	5/15/53	Night	Di	21–45	81–45

* Specimen mutilated.
† Off Mississippi River delta (see text).

Capture records are given in Table I in chronological order. Standard length (S. L.) measurements are

from the tip of the bill to the caudal end of the urostyle. Metal nets used for collection are high-speed plankton samplers (see Fish and Wildlife Service Special Scientific Report: Fisheries, No. 88). All specimens were taken either at, or within, five meters of the surface.

In addition to the foregoing collections, information concerning the capture of approximately 30 juvenile sailfish and one larval swordfish was furnished by Stewart Springer. The juvenile sailfish, ranging in length from about 20 to 65 mm., were taken by dipnet in August and September, 1953, during a cruise of the M/V OREGON, in an area extending from 28°50′ North, 88°50′ West to 29°10′ North, 88°00′ West, about 30 miles east southeast of the Mississippi Delta. The larval swordfish, although not taken in the Gulf of Mexico, was captured in such close proximity that its inclusion in this presentation seems justified.

These capture records strongly indicate that parts of the Gulf of Mexico serve as nursery grounds for sailfish and swordfish. In partial support of this contention, J. L. Baughman found that 17 out of 18 sailfish boated off Port Isabel, Texas, in August, 1940, had ova in all stages of development, and that several females taken later in the season had ova running from them (1941, COPEIA (1): 33–7).

Although adult sailfish are taken regularly in the Gulf of Mexico, only three authentic records exist concerning the presence of swordfish above larval size in this area. On June 17, 1949, a dead specimen, estimated to be 12 to 14 feet in overall length, was found washed up on the beach of Padre Island, Texas, by Charles Urschel, Jr. (Kramer, 1950, COPEIA (1): 65). A five-foot specimen (tip of lower bill to caudal fork) weighing 105 pounds was caught in Barataria Bay, Louisiana, on August 2, 1946, by Richard R. Foster, according to Harvey Bullis, of the U. S. Fish and Wildlife Service. On June 14, 1954, a 39-inch swordfish (tip of upper bill to caudal fork) was taken on a long line from the M/V OREGON, at a depth of ten fathoms, at 27°16′ North latitude, 90°25′ West longitude.—EDGAR L. ARNOLD, JR., *U. S. Fish and Wildlife Service, Galveston, Texas.*

ADDITIONAL RECORDS OF TWO FISHES, *ERIMYZON SUCETTA KENNERLYI* AND *HADROPTERUS COPELANDI*, FROM SOUTHERN ONTARIO, CANADA.—The University of Western Ontario, with financial assistance from the Research Council of Ontario, has since 1946 been carrying out a limnological investigation of central Lake Erie. Among the fishes caught during this period in seining and gill-netting operations were two species, *Erimyzon sucetta kennerlyi* (Girard) and *Hadropterus copelandi* (Jordan), which have a limited distribution in Ontario; consequently, the following note may be of interest.

On August 19, 1953, an immature specimen (46 mm. standard length) of the western lake chubsucker, *E. sucetta kennerlyi*, was collected from a marsh pond which communicated with the adjacent waters of Rondeau Bay at Erieau, Ontario. In 1954 in the same locality two mature females, one (131 mm. standard length) on July 2 and another (202 mm. standard length) on August 7, were caught in gill-nets. Although intensive seining and gill-netting have been carried out in other parts of Rondeau Bay no further specimens have been captured. During the summer at least, this species was apparently restricted to shallow marshy ponds on the margin of the bay.

Scott (1952, COPEIA (3): 203) described the distribution of the western lake chubsucker in Ontario as follows: "Ponds on both Long Point and Point Pelee on Lake Erie, and in Lake St. Clair." Rondeau Bay lies about 40 miles east of Point Pelee and about 100 miles west of Long Point; thus, the records outlined earlier do not represent an extension of the known range of the species in Ontario. However, since the ponds in the marshes at Rondeau Bay are similar to those in Long Point and Point Pelee, the records indicate that wherever suitable habitats exist on the Ontario shore of Lake Erie the western lake chubsucker will probably be found.

The channel darter, *Hadropterus copelandi*, was collected by members of this department from sand and gravel beaches in several localities along the north shore of Lake Erie. The locality records, with the number of specimens in parentheses, are as follows: Port Burwell, July 6, 1950 (2) by Dr. W. M. Sprules; Erieau, June 20 (1) and July 10 (1), 1951; Port Burwell, July 7, 1951 (1); Erieau, July 7 1952 (5), identification confirmed by Dr. W. B. Scott; Point Pelee, June 24, 1953 (17); and Erieau, June 23 (1) and July 24 (3), 1953. The collection includes immature and mature individuals.

Scott (1954, Freshwater Fishes of Eastern Canada, Univ. of Toronto Press, p. 89) stated that in Ontario the channel darter has been found only in the Detroit River. In so far as Port Burwell is about 180 miles east of the Detroit River, our records represent a marked extension of the known range of this darter. Moreover, the capture of the species at Erieau in three successive years suggests that the fish is now well established in that locality.

All specimens of each species are in the fish collection of the University of Western Ontario.—D. M. SCOTT, *Department of Zoology, University of Western Ontario, London, Canada.*

THE 2-3 INTERVERTEBRAL JOINT IN THE FISH GENUS *CATOSTOMUS*.—In the ostariophysine fishes the anterior 4 or 5 vertebrae are specially modified to form the *pars suspensorium*

of the Weberian apparatus. A varying degree of fusion of the vertebral parts occurs in the different members of this group and has led in the past to erroneous estimates as to the parts actually involved in the formation of the Weberian apparatus. In relation to the centra of these vertebrae, numbers 2 and 3 are frequently found in a fused condition and appear to be but a single vertebral centrum. Baudelot (1868, Bull. Soc. Sci. Nat. Strassbourg, 1(6&7): 87–109), Sachs (1912, Rev. Suisse Zool., 20(4): 725–60), Chranilov (1927, Zool. Jahrb. (Anat.), 49: 501–97) and Nelson (1948, Jour. Morph., 83 (2): 225–51) have been the chief contributors in this field.

Sachs and Chranilov in particular have shown that in various cyprinid genera the 2–3 intervertebral joint is either fused, open, or in some intermediate degree of fusion. The author's own work with catostomids has shown similar conditions to prevail. As to which cyprinid genera have the centra open and which fused Chranilov and Sachs disagree.

TABLE I

THE CONDITION OF THE 2–3 INTERVERTEBRAL JOINT IN *Castostomus c. commersoni**

Standard length (mm.)	External condition†	Internal condition†
14	Open suture	Open space§
16	Open suture	Open space§
17	Open suture	Open space§
96	Open suture	Open space
99	Open suture	Open space
141	Open suture	Open space
161	Open suture	Open space
192	Open suture	Open space
196	Open suture	Open space
203	Open suture	Open space
206	Open suture	Open space
220	Obliterated	Slight central opening
249	Line suture	Open space
258	Line suture	Open space
287	Obliterated	Slight central opening
358	Obliterated	Slight central opening
380	Obliterated	Slight central opening
396	Obliterated	Slight central opening
410	Obliterated	Slight central opening
418	Obliterated	Slight central opening
425	Obliterated	Slight central opening
450	Obliterated	Slight central opening
463	Obliterated	Slight central opening
476	Obliterated	Slight central opening

* All of these specimens were obtained through the cooperation of the Wisconsin Conservation Department.

† When the suture becomes fused, it is visibly obliterated. When the 2–3 intervertebral joint becomes fused, the intervertebral space becomes crowded out accordingly.

§ In the 14–16-mm. stages (several not listed here), only the anterior 4 vertebral centra are formed, with the remainder of the vertebral column being simple notochord. In the 16–17-mm. stages, additional centra form caudad to those of the Weberian apparatus (1, 2, 3 and 4).

This previous work was done by comparing morphologically a series of Weberian apparatus from "adult" specimens. The present work has been done on a series of specimens of a single species arranged by standard lengths (SL) and thus for all practical purposes by ages. The results of this study give a probable explanation for the disagreement of the previous workers.

In *Catostomus commersoni commersoni* (Lacépède), the definitive adult condition of the 2–3 intervertebral joint is fused. In specimens of less than about 250 mm. SL however, the joint is present either as a visible suture or clearly open (Table I). The transition period from the open to the fused condition appears to lie between 200 and 250 mm. SL. In the very early periods, up to about 16 mm., only those centra involved in the formation of the Weberian apparatus are differentiated from the notochord. Subsequently additional centra are added posteriorly from the Weberian apparatus caudad.

In *Catostomus catostomus catostomus* (Forster), the definitive adult condition of the 2–3 intervertebral joint is open. In a series of 20 specimens of this species, none demonstrated any tendency towards fusion of this space.

It is therefore quite evident that the use of the condition of the 2–3 intervertebral joint as a systematic criterion must be based upon truly definitive adult specimens. The use of specimens of different sizes (as representation of ages) would account for the differences in the results obtain by Chranilov and Sachs for the same cyprinid genera.

In the genus *Catostomus*, where other criteria have shown a natural subdivision of the species into at least two main groups, this criterion should be very helpful. Here we find that some species have the 2–3 intervertebral joint fused while others have it open. Species that have this space definitely fused are: *C. commersoni* (Lacépède), *C. insignis* Baird and Girard, *C. macrocheilus* Girard, *C. occidentalis* Ayres, *C. columbianus* (Eigenmann and Eigenmann; formerly *C. syncheilus*), and *C. rimiculus* Gilbert and Snyder. Some species which have this space definitely open are: *C. catostomus* and *C. microps* Rutter. Data on hand for the other species of this genus are insufficient.—EDWARD M. NELSON, *Department of Anatomy, Stritch School of Medicine, Loyola University, Chicago 12, Illinois.*

OFFSHORE RECORDS OF THE TRIPLETAIL, *LOBOTES SURINAMENSIS*, IN THE GULF OF MEXICO.—Baughman (1941, Amer. Nat., 75: 574) quoted G. B. Skelton of Houston, Texas, as stating that he had seen the tripletail, *Lobotes surinamensis* (Bloch), 100 miles offshore in the Gulf of Mexico. However, no definite localities are

given for such observations. Baughman further reported a specimen having been taken 63 miles southwest of Cape San Blas Light, Florida. Gudger (1931, Amer. Nat., 65: 57 f.) quoted Percy Viosca, Jr. who said that the tripletail "occurs out in the gulf" in Louisiana, though no indication is made of how far out. Baughman (*op. cit.*, p. 573) reported it on Florida and Texas snapper banks in depths of 15 or more fathoms, and from the Campeche Banks in 25 fathoms. The record off Cape San Blas would be over a depth of approximately 155 fathoms. Three of the records listed below thus apparently extend materially the known offshore occurrence of this species, and five of them considerably increase the known depth over which it has been recorded.

On the night of May 8, 1954, the U. S. Fish and Wildlife Service vessel M/V OREGON was drifting approximately 165 miles southwest of Terrebonne Bay, Louisiana, the nearest point of land, at OREGON Station 1035, Lat. 26°40′N., Long. 92°00′W., over 890 fathoms. Giles W. Mead of the Fish and Wildlife Service and I were engaged in collecting small fishes which were attracted to a large light hung over the side of the vessel. Eventually a tripletail, 397 mm. in standard length, drifted within reach of our dipnets. It made no attempt to escape as it was captured. Dr. Mead collected a second specimen under similar conditions on the night of May 25, at OREGON Station 1074, Lat. 24°00′N., Long. 96°50′W., over 575 fathoms, about 50 miles east of the southern end of the Mexican Laguna Madre. I cannot say whether either of these individuals was attracted to the light or whether they merely happened to drift within reach. I observed the third specimen on June 10, approximately 21 miles southeast of Port Aransas, Texas, at Lat. 27°42′N., Long. 96°44′W., over 19 fathoms. This individual floated on its side until the ship came very close, when the fish slowly dove out of sight. The fourth tripletail was observed as it floated by while the vessel was moving very slowly. Like the others, it showed no apparent reaction to the presence of the ship. This specimen was seen on June 13, at OREGON Station 1103, Lat. 27°00′N., Long. 92°00′W., over 600 fathoms some 145 miles southwest of Terrebonne Bay. The fifth was seen by a crewman, Frank Hightower, as he stood wheel watch on June 13. The vessel was under way at Lat. 27°02′N., Long. 91°48′W., over 850 fathoms, some 140 miles southwest of Terrebonne Bay. Mr. Hightower stated that the fish was near a piece of floating debris. That this species may frequently be found in company with some floating object has been reported by Gudger (*op. cit.*, p. 68). All of the specimens reported on above were floating on their side, a habit noted by Gudger and by Gunter (1945, Publ. Inst. Mar. Sci. Univ. Tex., 1 (1): 62). The latter four specimens were all approximately 12 inches in total length.

Harvey R. Bullis, of the U. S. Fish and Wildlife Service, writes me that he collected two small tripletails, 29 mm. and 50 mm. in total length, on July 24, while dipnetting at night from the OREGON. These were taken at OREGON Station 1137, Lat. 28°00′N., Long. 88°01′W., over 1300 fathoms some 92 miles southeast of the Mississippi River delta.

I wish to thank Dr. Mead and Mr. Bullis for allowing me to include the specimens they collected, and Mr. Stewart Springer, Chief of the OREGON operations, for making possible my presence aboard the OREGON during it's Cruise No. 23.—DAVID K. CALDWELL, *Department of Biology, University of Florida, Gainesville, Florida.*

OBSERVATION ON SCHOOLING JUVENILE TUNA, *EUTHYNNUS ALLETTERATUS*, IN THE GULF OF MEXICO.—During the past four years hundreds of night-light collections have been made from the M/V OREGON in the offshore waters of the Gulf of Mexico. Unique among the many observations made during this period was one on the night of July 19, 1954, at OREGON station 1127, position 29°5′N. Lat., 88°10′W. Long., over a depth of 450 fathoms.

Shortly after 9:00 PM, two schools of small fish passed in quick succession under the light. Both were made up of approximately 200 individuals swimming at the surface in a compact, amoeboid-shaped school which permitted me to get one dip-net scoop from each school. A total of 96 specimens of *Euthynnus alletteratus* (Rafinesque) that ranged from 20 to 31 mm. fork length (ave. 25 mm.) were captured. Escaping individuals from each school dispersed, sounded to a depth of 6 to 8 feet, and reformed their respective schools. These continued to pass back and forth under the light several feet below the surface, never again approaching near enough to the surface to permit additional captures. While passing back and forth under the light the two schools often came within a few inches of each other but always retained their separate identities without observed exchange of individuals.

After about one-half hour several small (5 to 8 inch) individuals of *Caranx hippos* appeared and immediately attacked the schooling fish. Almost instantly the schools dispersed and disappeared. *E. alletteratus* 15 to 172 mm. long have been commonly found beyond the edge of the continental shelf in the Gulf throughout the summer months. However, this is the only occasion when scombrids of this size range have been observed in schooling associations.—HARVEY R. BULLIS, JR., *Exploratory Fishing Section, U. S. Fish and Wildlife Service, Pascagoula, Mississippi.*

FIRST RECORD OF THE SHOVELNOSE STURGEON, *SCAPHIRHYNCHUS PLATORYNCHUS*, FROM THE TOMBIGBEE RIVER, ALABAMA.—A specimen of the shovelnose sturgeon, *Scaphirhynchus platorynchus* (Rafinesque), was caught on November 13, 1953, in the Tombigbee River near Epes, Alabama, on a trot line which was set by a commercial fisherman for catfish. This specimen, now incorporated into the Ichthyological Collection of the University of Alabama (Acc. No. 401), is an adult female with the abdominal cavity completely filled with eggs. The following data were taken: total length, 835 mm.; standard length, 720 mm.; head length, 191 mm.; body depth, 73 mm.; snout tip to outer barbel, 75 mm.; inner barbel to front of mouth, 41 mm.; length of inner barbel, 42 mm.; length of outer barbel, 51 mm.; mouth width, 61 mm.; dorsal plates, 22; lateral plates, 47; ventrolateral plates, 13; dorsal rays, 30; and anal rays, 17. In general, these measurements and counts fall within the range of variation for the species as defined by Bailey and Cross (1954, Papers Mich. Acad. Sci., Arts and Letters, 39 (1953): 169–208). However, the number of dorsal, lateral, and ventrolateral plates in this specimen is above average, with the number of dorsal plates exceeding the published limits of variation; whereas the number of dorsal and anal rays is below average. Additional specimens would be needed to determine if these characters are constant.

Bailey and Cross have recorded this species only from the Mississippi and Rio Grande drainages. The new specimen, coming from the Mobile River basin, represents an extension of the known range of this sturgeon.—RALPH L. CHERMOCK, *Department of Biology, University of Alabama, University, Alabama.*

REVIEWS AND COMMENTS

FISHES OF THE MARSHALL AND MARIANAS ISLANDS. VOL. I. By Leonard P. Schultz and collaborators: Earl S. Herald, Ernest A. Lachner, Arthur D. Welander, and Loren P. Woods. Bull. U. S. Nat. Mus., 202, 1953: XXXII + 685 pp., 90 text-figs., 74 pls. $2.75.—The title of this important volume is much too modest, for this book not only gives lists and descriptions of the species collected in this area, but includes material from all over the Indo-Pacific for comparison. With this extensive material at hand the authors have come to the conclusion that the Indo-Pacific fauna is not so uniform as is generally supposed, but rather that, within this vast region which includes the Hawaiian Islands, Polynesia and Micronesia, the Indo-Australian Archipelago and Melanesia, and the area from Mauritius to the Red Sea, each area has numerous distinct species and subspecies of its own. In many instances the differences between related species in the different areas are slight and chiefly of coloration. In the introduction Schultz says: "The importance of coloration as a factor in the recognition of species and subspecies cannot be overemphasized." Personally I have always been reluctant to admit that slight differences in color or color pattern in fishes are of specific value, as it is well known that individual fishes can change their color under varying conditions. However, the authors of this volume have had the opportunity of observing live specimens and recording the color by means of color photographs; and by comparison of these photographs with the preserved specimens they have come to the conclusion that basic color patterns of brown, blackish shades, and light areas, which occur in preserved specimens of certain species and subspecies, are constant. Furthermore, the authors have had the advantage of studying very large collections.

On expeditions in connection with the atom-bomb tests of Operation Crossroads during 1946, about 50,000 specimens from the northern Marshall Islands were collected, and collections made in the southern Marianas yielded 15,000 specimens. These large collections enabled the authors to study the variability of certain species in a way never possible before. The 58 tables recording counts for related species are of great interest in this respect, not only showing the variability within each species but also bringing forward the characteristics of each separate species.

The lion's share of this volume was contributed by Dr. Schultz, the senior author. He wrote the introduction, the account of the Cephalochordata, of the Selachii, and of 20 families of the Teleostei, and he collaborated with Welander on the Dussumieridae, and with Woods on the Hemiramphidae, Exocoetidae, Pomacanthinae and Acanthuridae.

Woods reported on the Holocentridae, Carangidae, Chaetodontidae, Platacidae, Zanclidae and Siganidae; Herald reported on the Syngnathidae; and Lachner reported on the Apogonidae. The keys to the species generally refer not only to species of the Marshall Islands and the Marianas, but also to the other species of the Indo-Pacific and hence are useful for all workers on the ichthyology of this region.

Most of the plates are reproductions in black and white of kodachrome transparencies, hence representing living fishes or those recently dead. This first volume contains: "Families from Asymmetrontidae through Siganidae." In all, 6 new genera, 1 new subgenus, 59 new species, and 7 new subspecies are described.

We may be sure that all ichthyologists interested in the Indo-Pacific fauna will await with impatience the issue of the next volume of this extremely interesting work.—L. F. DE BEAUFORT, *De Hooge Kley, Amersfoort, Netherlands.*

FISCHKRANKHEITEN. By Dr. Phil. Wilhelm Schaeperclaus. Akademie Verlag, Berlin, 1954: 708 pp., 389 illus. DM 48.00 or $20.17.—There is no doubt that, to date, this is the definitive work on fish diseases. Marine fish parasites which have in the past been slighted in manuals of fish diseases, probably largely because remedial measures are even harder to apply there than in fresh water, come in for a good share of attention. Crustaceans of commerce are also treated and a surprising amount of information on other aquatic forms is included, dealing mainly with the influence of man-induced changes in the water.

The manual—for that is the nature of the book—is divided into a general portion treating of pathogenesis in the fish body, the steps leading to proper diagnosis, fish pathology in general and sections on prophylaxis and therapy. The second part of the book lists all better-known parasites and diseases (sic. author's preface—an understatement) including those of genetic and environmental orgin.

Specific remedial measures are suggested after every disease treated. Schaeperclaus starts out with parasitic crustaceans, next deals with the various groups of parasitic worms, and then treats Protozoa, Algae, Fungi, Bacteria and Viruses, in that order, as disease-causing organisms.

There are many tables to give an overview of large groups such as the Sporozoa and Trematoda but unfortunately there are no keys to the forms. The illustrations, however, are clear, adequate, and certainly copious.

The non-parasitic diseases are of special interest because the intensive land and water utilization of Central and Western Europe—the main area from which such information is available—makes it imperative to discuss toxic effects of many and varied effluent substances. This will be of interest not only to stream biologists but also to the conservation-minded public at large.

Those accustomed to American conditions may think that the carp receives an undue amount of attention in this book even to the extent of describing and advocating their immunization against infectious ascites (*Pseudomonas punctata*) by vaccination. One must consider, however, that an epizootic in European carp ponds may go as far as causing regional protein shortages.

The bibliography is impressive; it covers 29 pages and carries over 600 citations from sources which are concentrated in Germany and France but spread over the entire world disregarding iron or other curtains.

My mother tongue is German but I have since become used to the clarity and ease with which one can express even complex ideas in English. It is unfortunate that Dr. Schaeperclaus' style may give some hard nuts to crack to those of my colleagues who rely on their Ph.D. German but it is even more unfortunate that a translation of this excellent work is not likely to be expected.—JOHN E. BARDACH, *Department of Fisheries, School of Natural Resources, University of Michigan, Ann Arbor, Michigan.*

FROM FISH TO PHILOSOPHER. By Homer W. Smith. Little, Brown and Company, Boston, 1953: xii + 264, 12 figs. $4.00.—Those who have read *Kamongo* will find in this fascinating volume the same literary skill here adapted to a lucid sketch of the history of the earth and the mechanism of evolution. It is a masterful summary of three decades of research by an eminent physiologist on the kidney, a structure that is mainly responsible for maintaining the internal environment of the body. "This is the story of how our kidneys work, and of how they came to work the way they do—which is the story of the evolution of the vertebrates, of which man is the most notable and intelligent species and the only philosopher."

We learn how the glomerular kidney served as an escape from the waterproof armor of the ostracoderms; the ingenious method developed by elasmobranchs to prevent the constant osmotic loss of water; the development of the aglomerular kidney by certain teleost fishes that are confined to the sea (e.g., *Lophius, Syngnathus, Gobiesox*, etc.); the system for reducing water excretion and for varying the permeability of the skin by the Amphibia; the replacement of urea by uric acid in the terrestrial reptiles and birds; the extraordinary degree to which urine can be concentrated in the desert-adapted kangaroo rat (the only mammal on record that can drink sea water); etc. Of the human kidney, Dr. Smith says: "[it] manufactures the kind of

urine that it does, and it maintains the blood in the composition which that fluid has, because this kidney has a certain functional architecture; and it owes that architecture not to design or foresight or to any plan, but to the fact that the earth is an unstable sphere with a fragile crust, to the geologic revolutions that for six hundred million years have raised and lowered continents and seas, to the predacious enemies, and heat and cold, and storms and droughts; to the unending succession of vicissitudes that have driven the mutant vertebrates from sea into fresh water, into desiccated swamps, out upon the dry land, from one habitation to another, perpetually in search of the free and independent life, perpetually failing, for one reason or another, to find it."

Much of the more technical discussion is relegated to some 40 pages at the end of the book, an action which serves to enhance the readability of the 13 chapters. A 10-page index concludes the work, which is interestingly illustrated.

Every biologist, whether a student or an established investigator, will profit from reading this book. It is an absorbing account of original research told by a specialist who has not allowed himself to fail to see the forest for the trees.—ROBERT RUSH MILLER, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

A STUDY OF THE FAUNA OF THE BROWN SHRIMP (*PENAEUS AZTECUS* IVES) GROUNDS IN THE WESTERN GULF OF MEXICO. By Henry H. Hildebrand. Publ. Inst. Marine Sci., 3 (2), 1954: 366 pp., 7 figs. $1.50. —Observations of 225 trawl hauls made by shrimping boats in the western portion of the Gulf of Mexico (west of the 90th meridian) are reported over the period from October 20, 1950, to August 8, 1951. About 3.6 percent of actual trawling time was lost because of shark damage. A total of 157 species of fishes, 104 invertebrates and 2 ascidians were noted. Species considered to be rare, e.g., *Raja texana* and *Upeneus parvus*, were not infrequently found to be abundant and widespread when trawling gear was used at the proper depth. Interesting new records for a number of species in various parts of the Gulf are cited, as well as miscellaneous observations on habits, particularly feeding habits and bathymetric distribution. The greatest abundance of species of marine organisms is shown to be along the Coastal shelf in waters of high salinity and at depths of 12 to 25 fathoms. On the basis of the most important crustaceans, fishes and mollusks, designations of several communities characterized by particular combinations of these animals are made. Four major grounds for the brown shrimp are circumscribed and the pink shrimp grounds in the Gulf of Campeche are also described. Many data on the distribution and relative abundance of the animals trawled are presented.—ROBERT RUSH MILLER.

THE SCIENTIFIC PAPER. HOW TO PREPARE IT. HOW TO WRITE IT. By Sam F. Trelease. Ed. 2. Williams and Wilkins Co., Baltimore, 1951: xii + 163 pp., illus. $2.50.—One of the greatest stumbling blocks faced by research workers is the chore of writing up data in an acceptable fashion for publication. This manual is designed to lessen greatly the difficulties of that task. Students in particular often fail to realize that writing intelligently is an essential part of their training, and that a scientist is judged very heavily on the quality of his final product. The gathering of data, no matter how significant, is of little value if it cannot be presented in a clear and concise fashion to the reader. The preparation of results for publication is in many ways the most important phase in any scientific investigation. Very few people write easily and those who can turn out a good scientific paper in a short period are rare indeed. Most candidates for the Ph.D. degree should plan on spending at least six months on the writing of a dissertation amounting to around 100 typewritten pages.

Included in this compact volume is a discussion of the research problem, of the process followed in writing a paper, the grammatical foundations of good form and usage, an illustrated account of tables, figures, drawings, graphs and photographs, a short chapter on prepublication review, and the procedure for proofreading. A useful bibliography is followed by a 5-page index. Study of this book and practice in its recommendations should be made mandatory for all graduate students and will prove enormously helpful to virtually all professional scientists.—ROBERT RUSH MILLER.

Editorial Notes and News

ASIH 1955 meeting San Francisco

THE American Society of Ichthyologists and Herpetologists will hold its thirty-fifth annual meeting, jointly with the annual meeting of its Western Division, June 27 to July 1, 1955, at San Francisco, California. The California Academy of Sciences, in Golden Gate Park, will serve as the host institution. Hotel headquarters will be at the Hotel Whitcomb, 8th and Market Streets. This will be the Society's first meeting in San Francisco, and its first meeting on the Pacific coast since 1938. The local committee will comprise ROLF L. BOLIN, LILLIAN DEMPSTER, ROBERT P. DEMPSTER, WILLIAM A. GOSLINE, EARL S. HERALD, GEORGE S. MYERS, PAUL R. NEEDHAM, JOSEPH R. SLEVIN, ROBERT C. STEBBINS, MARGARET H. STOREY, STANLEY H. WEITZMAN, and W. I. FOLLETT, Chairman. The following events have been scheduled:

Monday, June 27, at the Whitcomb Hotel: Board of Governors meeting, 7:30 PM.

Tuesday, June 28, at the California Academy of Sciences:
Registration, 8 to 10 AM (a registration fee of $1.00 will be charged to help defray the expenses of the meetings). *Submitted papers*, 10 AM to 12 NOON. *Group photograph*, 12 NOON. *Symposium* ("Aquaria" ; EARL S. HERALD, Chairman), 1 to 5 PM, and possible evening session.

Wednesday, June 29, at the California Academy of Sciences:
Submitted papers, 9:30 AM to 12 NOON. *Symposium* ("Phylogeny of the Salientia"; organized by D. L. JAMESON; GEORGE S. MYERS, Chairman), 1 to 4 PM. *Smoker; exhibit of live reptiles and amphibians of western U. S.;* in Steinhart Aquarium; 8 PM.

Thursday, June 30, at the California Academy of Sciences:
Submitted papers, 9:30 AM to 12 NOON. *Symposium* ("Morphology of Fishes"; ROLF L. BOLIN, Chairman), 1 to 4 PM. *Business meeting*, 4 to 5:30 PM. *Banquet* (at *Fisherman's Wharf*), 7 PM.

Friday, July 1, leaving from Hotel Whitcomb at 8 AM:
Joint field trip to Tomales Bay (sand beach at Youngs Landing); collecting with 700-foot beach seine; herpetological collecting; visit to Muir Woods National Monument.

Saturday, July 2, at the Natural History Museum, Stanford University:
Open house, after 10:30 AM, featuring ichthyological and herpetological collections, libraries, special exhibits and demonstrations, including old literature, a comparative display of museum and field containers, closures, tags, labels, data sheets, etc. (from various museums), special equipment and techniques, and the work of the George Vanderbilt Foundation.

Sunday, July 3, at the Hopkins Marine Station, on Monterey Bay: *Open House*, after 2 PM. Program to be announced.

All members, and especially those driving to or from the meetings via northern or eastern routes, are invited to visit, either before or after the meetings, the *Sagehen Creek project* of the University of California, near Lake Tahoe. This is a high-mountain fishery station for long-term ecological and distributional studies, featuring stream draining and electrical shocking to collect fishes; an underwater observation tank; two-way fish traps; and microtemperature apparatus. There are good camp sites in this picturesque region.

Of interest to ASIH members also will be the annual meeting of the American Society of Mammalogists, June 12–16, at Los Angeles, and that of the Pacific Division of the American Association for the Advancement of Science, June 20–25, at Pasadena. As a part of the AAAS program, the Pacific Section of the American Society of Limnology and Oceanography will hold two half-day sessions, June 22–23, on the use of self-contained underwater breathing apparatus ("SCUBA").

Those desiring further information on the ASIH meetings should communicate with MR. W. I. FOLLETT, Curator of Fishes, California Academy of Sciences, San Francisco 18, California.

U. of Miami Marine Laboratory

THE Department of Marine Science of the University of Miami calls attention to courses leading to a Master's degree with specialization in Marine Biology, Oceanography and Fisheries. Rising interest in the various aspects of the science of the oceans has made it impossible to meet the demand for trained marine biologists, oceanographers and fishery biologists.

Interested students with a Bachelor's degree in Zoology, Physics, Chemistry or related sciences should contact The Department of Marine Science, University of Miami, Coral Gables, Florida, for further information.

The research counterpart of the Department of Marine Science is the Marine Laboratory of the University of Miami. A wide variety of research projects, both in "pure" and "applied" science, are conducted under the supervision of the faculty

members who give the academic courses. This combination of research and teaching is believed to benefit both. The research projects are supported by a wide variety of agencies and individuals—government, industry and private. Students are frequently offered the opportunity to take part in research projects, increasing the value of their professional training. Part-time jobs and other financial assistance are available to qualified students.

Genus *Bombina*

NOTICE of possible use by the International Commission on Zoological Nomenclature of its Plenary Powers in the following case: *Bombina* Oken, 1816 (Class Amphibia, Order Anura), conservation of. Application in Bull. Zool. Nomencl., 11 (4): 132–3. Published Feb. 28, 1955. File No.: (Z. N. (S.) 843). Any specialist who desires to comment on this application should do so immediately and should refer to the Commission's File Number given above. Comments should be mailed to FRANCIS HEMMING, Secretary to the International Commision on Zoological Nomenclature, 28 Park Village East, Regent's Park, London, N.W. 1, England.

News notes

DR. DAVID L. JAMESON, Department of Biology, University of Oregon, has been awarded a $5,000-a-year grant by the Atomic Energy Commission for a 3-year study of the population genetics of the Pacific treefrog, *Hyla regilla*. The University of Oregon is contributing a like amount.

COL. MARTIN LALOR CRIMMINS, 78, died on February 5, 1955, in San Antonio, Texas. COL. CRIMMINS, a member of the ASIH since 1940, figured prominently in this country in the development of serum for the treatment of snake bite.

The University of North Carolina Institute of Fisheries Research at Morehead City, North Carolina, has adopted a finfish program. DR. WILLIAM E. FAHY has been designated Chief, Finfish Investigations, and at present is engaged in outlining and organizing the long-range fish studies. The researches will be aimed primarily at commercial fish species.

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Affiliations

The American Society of Ichthyologists and Herpetologists is a member of the American Institute of Biological Sciences and of the Division of Biology and Agriculture, National Research Council, and is an affiliate of the American Association for the Advancement of Science. An annual contribution is made to the publication of the Zoological Record.

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